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Construction Engineering Research Laboratory

US Army Corps of Engineers®
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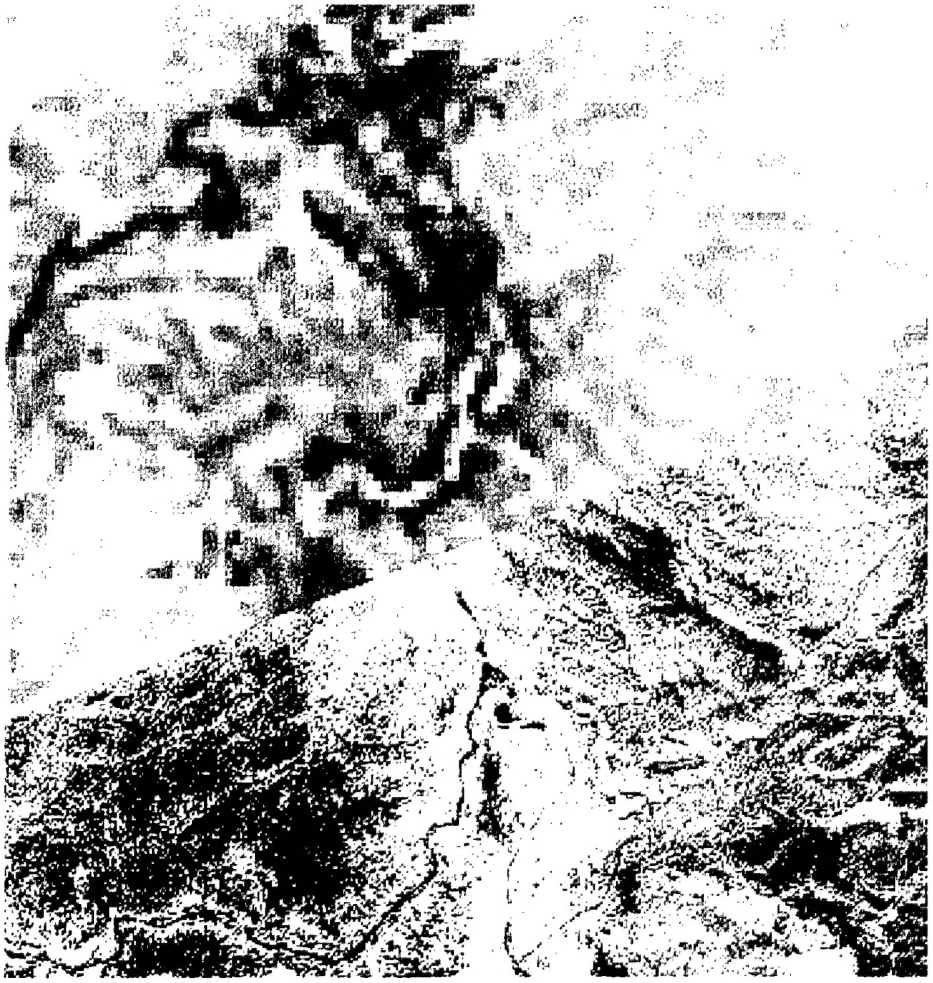
Removing the Veil: Interest of Military Land Managers in Using Declassified and Classified Imagery

by Robert C. Lozar, Wade Smith, William Croisant, Glenn Rasmussen, and Thomas Hale

August 2000



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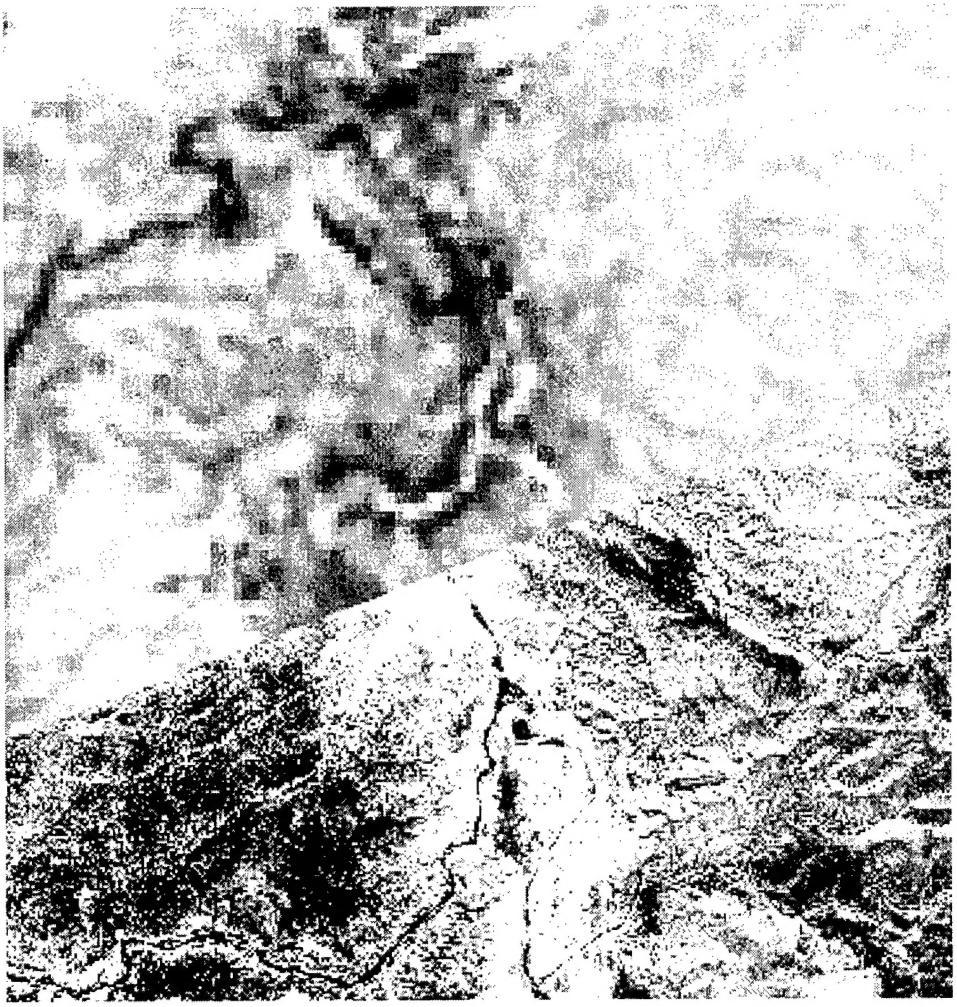

United States Department of Defense
Legacy Resource Management Program

The Legacy Resource Management Program was established by the Congress of the United States in 1991 to provide the Department of Defense (DOD) with an opportunity to enhance the management of stewardship resources on over 25 million acres of land under DOD jurisdiction.

Legacy allows DOD to determine how to better integrate the conservation of irreplaceable biological, cultural, and geophysical resources with the dynamic requirements of military missions. To achieve this goal, DOD gives high priority to inventorying, protecting, and restoring biological, cultural, and geophysical resources in a comprehensive, cost-effective manner, in partnership with Federal, State, and local agencies, and private stakeholders.

Legacy activities help to ennsure that DOD personnel better understand the need for protection and conservation of natural and cultural resources, and that the management of these resources will be fully integrated with, and support, DOD mission activities and the public interest. Through the combined efforts of the DOD components, Legacy seeks to achieve its legislative purposes with cooperation, industry, and creativity, to make DOD the Federal environmental leader.

This document is a Legacy Program work product and does not suggest or reflect the policy, programs, or doctrine of the Department of the Army, Department of Defense, or United States Government.

Cover image: (Top) LandSat Multispectral Scanner image of the Upper San Pedro River Basin near Fort Huachuca, AZ, taken from space in 1985 at 60-meter resolution compared with 1965 declassified image (bottom) at about 3-meter resolution.

Foreword

This research was conducted for the Legacy Resource Management Program under the auspices of the Office of the Deputy Under Secretary of Defense for Environmental Security, ODUSD(ES). Funding was accomplished under Military Interdepartmental Purchase Request number W31RYO91603438, *User Catalogue of Classified Imagery Applications to Military Test and Training Lands*. The technical monitors were L. Peter Boice and Bruce Beard, ODUSD(ES).

This work was performed by the Ecological Processes Branch (CN-N) of the Installations Division (CN), Construction Engineering Research Laboratory (CERL). The CERL principal investigator was Robert C. Lozar. Wade Smith is a senior researcher with Mitretek Systems. Stephen E. Hodapp is Chief, CN-N, and Dr. John Bandy is Chief, CN. The staff from many U.S. Army installations provided data. Additional data were acquired from the U.S. Geological Survey (USGS) in Sioux Falls, SD. The technical editor was Linda L. Wheatley, Information Technology Laboratory. The associated Technical Director was Dr. William D. Severinghaus. The Acting Director of CERL is Dr. Alan W. Moore.

CERL is an element of the U.S. Army Engineer Research and Development Center (ERDC), U.S. Army Corps of Engineers. The Director of ERDC is Dr. James R. Houston and the Commander is COL James S. Weller.

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1 Introduction

Background

During the Cold War era, massive amounts of remotely sensed national defense intelligence data were collected. These data include satellite-based photography and digital imagery gathered from a variety of instruments. The imagery remained highly classified for many years so extra-territorial threats to the United States would not know the extent of U.S. technological capabilities or have access to the intelligence that could be derived from these sources. The collected materials and supporting technologies remained inaccessible to potential users within the United States.

Three events have changed the status of these materials. First, the early technology has become outmoded by advances in the civilian sector, making secrecy about it unnecessary. Second, the breakup of the Soviet Union has removed that country as a major threat and decreased the need to keep these materials highly classified. Third, Presidential Executive Order 12951 (22 February 1995) and initiatives of the U.S. Congress have provided a framework for the declassification of and public access to some of this material. A resulting initiative, the Government Applications Task Force (GATF), reviewed the feasibility of applying national imagery assets to issues of a nontactical nature and provided encouraging recommendations.

These photographic and digital images will provide unique opportunities for military land managers. The intelligence imagery now less highly classified is an archive of the extent and condition of our Federal lands long before other sources of comparable detail were available. This intelligence archive greatly enhances a land manager's ability to identify changes or identify objects on the land, the locations of which have since been lost. In addition, the availability of historical and current imagery can objectively support the government's continuing professional land management practices and thus help avert or resolve litigation.

Figure 1, for example, is a formerly classified satellite photograph taken over Fort Knox, KY, in October 1964. It was scanned on a 600-dots per inch (dpi) flatbed scanner. The original negative is detailed enough that it can be scanned at

5,200 dpi. Single maneuver tracks are visible. For comparative purposes, this image is roughly equivalent to the best civilian satellite imagery currently available (Figure 2). The 1990 SPOT* image shown in Figure 2 covers almost the same area as shown in Figure 1, shot at nearly the SPOT instrument's maximum 10-meter black and white resolution.

Figure 1. A formerly classified satellite photograph taken over Fort Knox, KY, in October 1964. The tank table at lower right is shown in Figure 3. (Paper printing of the images throughout this report significantly degrade the detail present in the originals.)

* SPOT = Systeme Probatoire pour l'Observation de la Terre (France's earth observation satellite).

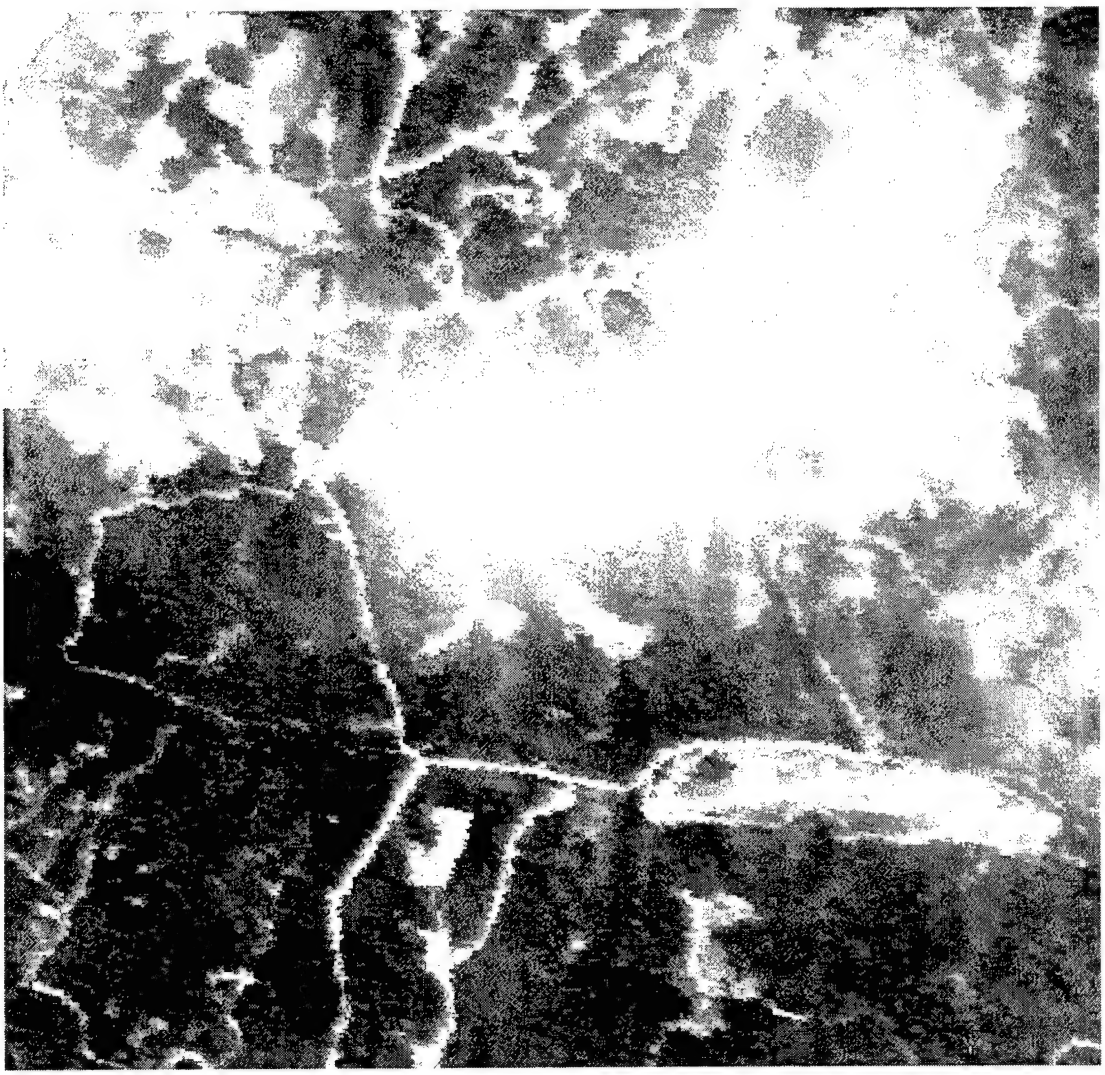

Figure 2. Comparable 1990 Civilian SPOT satellite image of the same area at Fort Knox. Resolution is 10 meters (about 33 feet).

The film from which Figure 1 was scanned is of such high quality that the original negative can be enlarged about 32 times before individual bits of the light-sensitive photographic grain can be seen. The digital video-micrograph image in Figure 3 is also at about this degree of enlargement and shows half the tank table seen in Figure 1. In Figure 3, objects about 9 feet (~3 meters) in size can be identified. The 1964 image shows portions of Fort Knox with 25 times more detail than could be obtained even a decade later when the first civilian satellite, LANDSAT, made satellite images publicly available. It is clear that the small portion of Figure 1 presented in Figure 3 is far superior in detail even though it was taken 35 years ago with instruments comparable to the best available today.

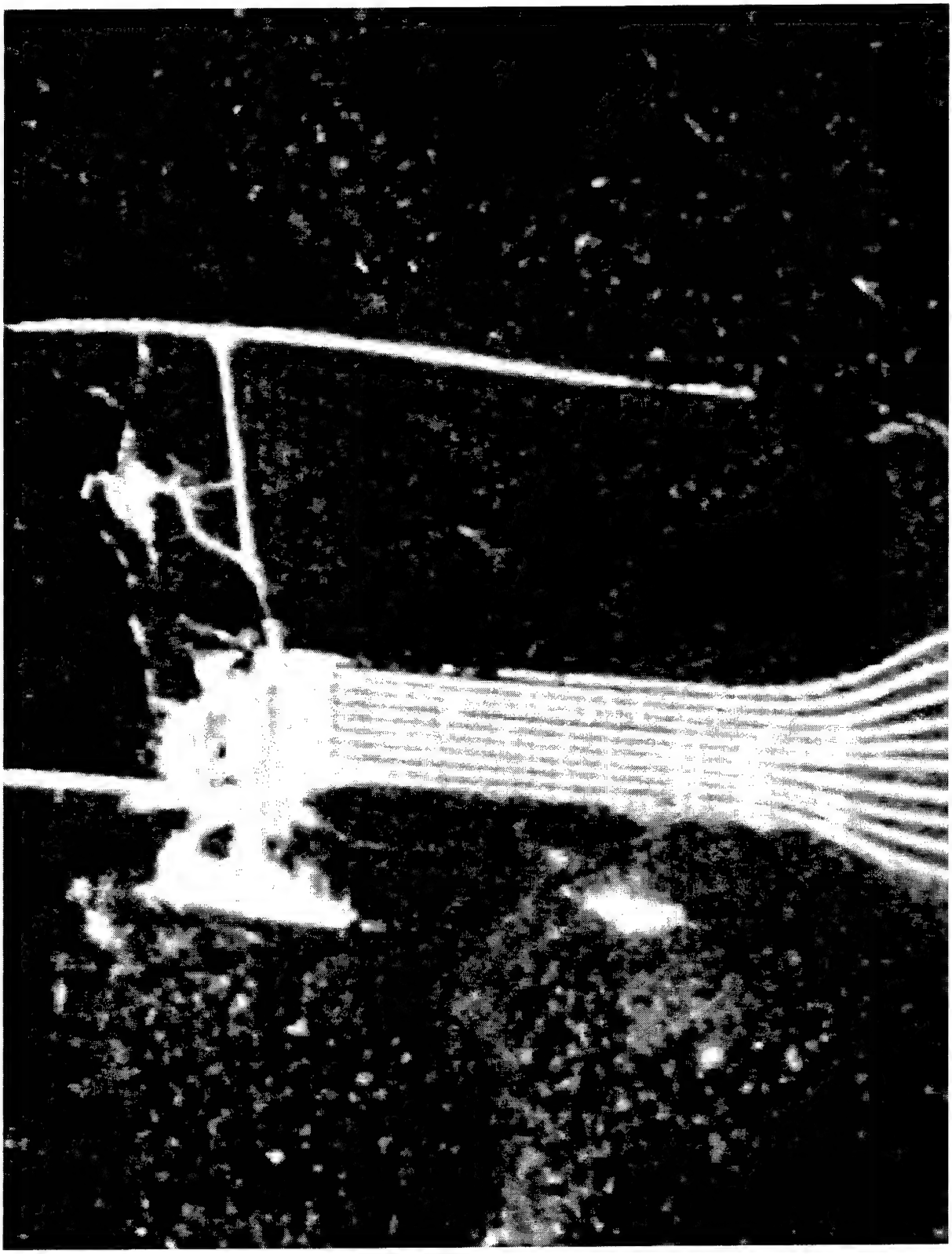

Figure 3. Tank table trails are easy to see and individual trees can be identified in these satellite images from 1964. It is likely that vehicles can be seen on the upper track.

Why should this imagery be used when civilian sensors are already available? High resolution has many advantages over less detailed images. In 1972 the Multi-Spectral Scanner (MSS) provided the first civilian images from space at resolutions of 80 meters. Figure 4 (left) shows a section of the cantonment area at Fort Huachuca, AZ. In the early 1980s the Thematic Mapper (TM) instrument made images available at a resolution of 30 meters. Figure 4 (center) shows the same Fort Huachuca area in a TM image. It is difficult to recognize objects in either civilian image. However, classified images were being taken from space at about 2-meter resolution before space imagery was available to civilians, and these images are now publicly available. Figure 4 (right) is the same area of the cantonment at Fort Huachuca in 1965. At a resolution of about 8 meters (much less than its potential), it shows easily recognizable objects even though this image was taken years before either the MSS or TM images.

In an evaluation of the character of the unclassified data available to the public, the following conclusions have been made:

1. Satellites were regularly imaging much of the United States almost from the beginning of their missions (as early as 1959).
2. Black and white photographic products of very high resolution from as early as the mid-1960s can be expected to be available for most of the United States.
3. Acquisition cost is minimal, and processing these photographic materials into digital form is also minimal.
4. Enough data exist that the statement may confidently be made that some images will exist for most installations.
5. For many installations without an alternative source of historical imagery, this is a unique archive that is only now available.

Figure 4. The same area with different sensors: MSS image (left, 1985), TM image (middle, 1997), declassified image (right, 1965).

As of July 1999, imagery taken after 1972 remained classified. However, in general the later images will have high detail, cover much less area than the earlier instruments, and continue to be panchromatic (black and white) in nature.

Based on preliminary work, some potential applications of these data were identified for several installations and land management needs. The types of initial applications include:

- Discovery of unauthorized/unrecorded hazardous disposal sites
- Archeological/cultural site prospecting
- Cost-effective monitoring for inaccessible locations
- Extending management and climate change trend analysis baselines
- Support for regional ecosystem management
- Streamlining NEPA by supporting adaptive monitoring and mitigation
- Determination of pre-deployment conditions
- Identifying land carrying capacity for military usage
- Habitat conservation management.

This inventory of possible applications provided strong evidence of the utility and breadth of application of the formerly classified imagery to land management for all the services. It suggested that a gap existed between the technology and its application to real needs. However, anecdotal evidence is not adequate to objectively identify and prioritize user interest. This area of potential imagery application requires exploration to identify the opportunities and prioritize those with the greatest benefit versus cost to the military services.

A proposal was made to the Legacy Resource Management Program to, in part, support such an investigation. The initial phase was funded in the summer of 1998. Two 1-year phases were outlined. The first phase was an objective, systematic, and broad investigation of potential installation needs in relation to the imagery available. This report is an objective summary and prioritization of military installation user interest as determined in Phase I.

Objectives

The objectives of this project were to identify the characteristics of declassified (or lesser classified) remote imagery resources and prioritize potential application of those resources in support of a service-wide user catalog of intelligence imagery applications for the Army military land manager. The purpose of this report is to objectively identify needs of installation land managers in relation to the imagery available and its applications.

Approach

Installations were surveyed to identify and prioritize potential user interest. Personnel contacted installation Directorates of Public Works (DPWs) on their potential need for remotely sensed land information to support their management and monitoring responsibilities. Surveyors also suggested to DPW individuals that the data source now available can be used to support their responsibilities in land management. The survey comments and surveyor suggestions were used to develop a sense of the breadth of application, the level of installation interest in each application, and the relative cost payback in terms of funds, timesaving, and increased work efficiency. The information collected was summarized to prioritize the highest value for newly declassified or lesser classified and classified resources for military land managers.

Scope

CERL's survey focused on Army installation land managers' needs. A similar survey effort was carried out (in cooperation with CERL) by Mitretek, Inc. (McLean, VA) for the other military services. Though the survey approaches were somewhat different between the two efforts, it is clear that most research findings are applicable service-wide and this work represents a DOD-wide product.

Most installation land managers surveyed have had only a passing exposure to the characteristics or means of handling the declassified imagery discussed here. Managers also expressed some reluctance to become involved with materials requiring a security clearance. Due to these considerations, most of this report will emphasize the user interest for declassified materials. A separate appendix classified as Secret has additional information for those personnel with an appropriate clearance to pursue imagery that is still restricted.*

This summary does not cover all imagery data that might be available. It also may not represent all the potential applications or user offices at an installation. It will, however, focus on a set of applications that has been determined to be of the greatest usefulness to installation personnel.

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* Qualified agencies may request Appendix E by applying to: r-lozar@cecer.army.mil.

Mode of Technology Transfer

This document is intended to provide a basis for generating interest in the imagery materials available. It is also intended to be a resource document for other agencies in providing guidance to the installations that:

- the imagery is available
- it may be of practical application
- facilities are in place to take advantage of these resources (Figure 5).

This report will be made available to the Army Environmental Policy Institute (AEPI) to assist Phase II initiatives. The ultimate beneficiary will be military land managers, usually in the installation planning, forestry, natural resource and environmental offices, which are normally part of the installation DPW.

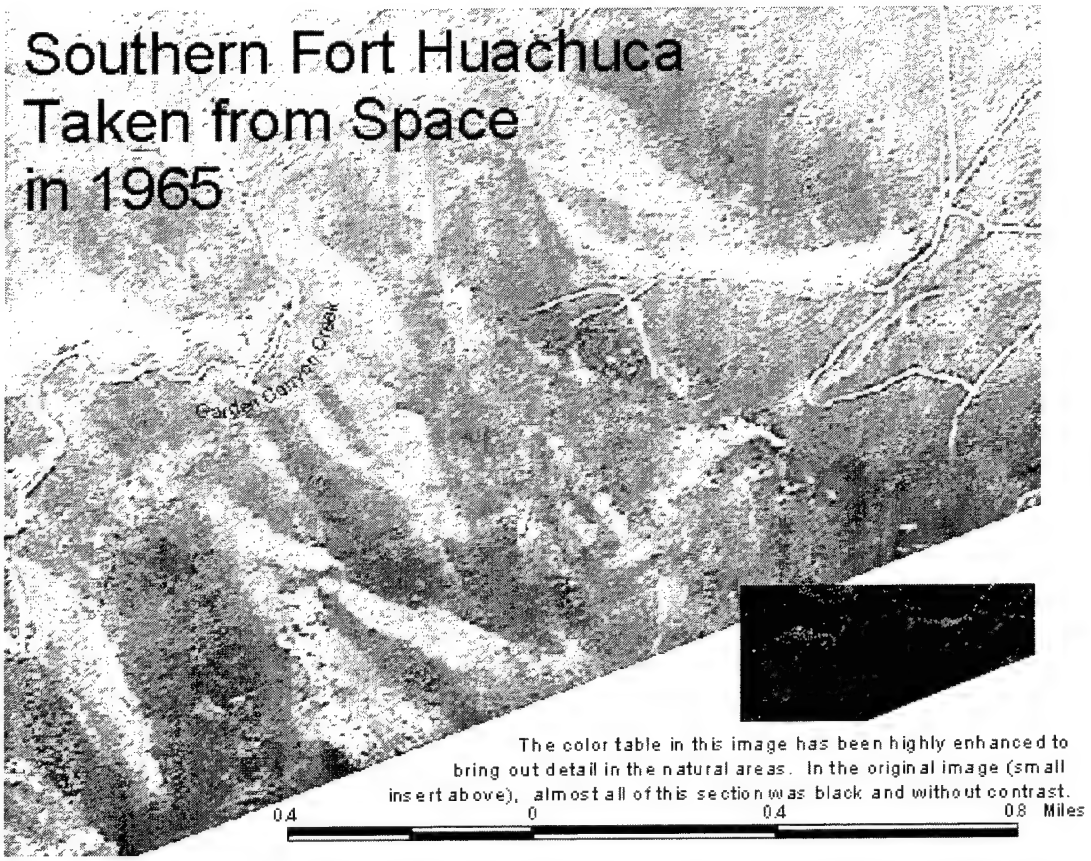

Figure 5. Digital manipulation techniques illustrated here allow users great flexibility in transferring this technology to installation land managers.

2 Army Installation Stated Needs and Interests

Procedure

It was decided early in this effort to use a standard installation questionnaire to develop an objective evaluation of relative priorities and a cost benefit determination.

A list of target installations was developed based on those that might provide the best information return for the effort expended. Installations on the list represented those that institutional knowledge suggested would most highly benefit. Table 1 lists the initial Army installations, those that were added or dropped, those that replied, and those for which at least some portion of the questionnaire could be filled out for this summary. Of the 34 installations contacted, 74 percent responded in a manner that was sufficient to generate a survey form that could be used in this analysis.

Next, to ensure that this research placed the least amount of burden on installation staff, an interviewing procedure with a set of supporting materials was developed. This standardized procedure allowed several researchers to obtain comparable responses among the various installations. Appendix A is the script developed for the initial "cold call" to the installation.

A set of example materials was then mailed (or e-mailed) to the identified POC (and often multiple POCs at any one installation). The purpose of the mailed material (Appendix B) was to illustrate applications and provide graphics for onsite review. The intent was to motivate individuals to think about these resources. The POCs rarely had time to do more than look at the document, but that was all that was expected as an initial contact. The materials proved to be invaluable as a common source to which interviewers and POCs could refer during the course of followup conversations.

Finally, the POCs were interviewed — usually by telephone, but occasionally an onsite visit was possible. Trips were made to five installations. Each interviewer used a standardized form (Appendix C) to ensure that all information was

gathered and placed in set locations for easy translation to a queriable database. Data from these forms are the basis for this analysis of user interest.

Table 1. Target installations included in survey.

Installation Name	Contacted	Replied	Surveyed
Army Environmental Center (AEC) MD	x	x	x
Fort Benning GA	x	x	x
Fort Bliss TX	x		
Fort Bragg NC	x	x	x
Fort Buchanan, PR	x		
Camp Bullis TX	x	x	x
Fort Campbell KY	x	x	x
Fort Carson CO	x	x	x
Fort Chaffee AR	x	x	x
Fort Drum NY	x	x	x
Dugway Proving Ground UT	x	x	x
Fort Eustis VA (and Fort Story)	x	x	x
Fort Gordon GA	x	x	x
Fort Greely AK	x	Included in Richardson	x
Fort AP Hill VA	x	x	x
Fort Hood TX	x		
Fort Sam Houston TX	x	x	x
Fort Huachuca AZ	x	x	x
Fort Irwin CA	x	x	By Mitretek
Fort Jackson SC	x	x	x
Fort Knox KY	x		
Koho'olawe Island HI	Now State Land		
Fort Lewis WA	x		
Camp McCoy WI	x	x	x
Fort Pickett VA	x	x	
Fort Polk LA	x		
Fort Richardson AK (includes Greely & Wainwright)	x		
Fort Riley KS:	x	x	x
Camp Ripley MN	x	x	x
Scholfield Barracks HI	x	x	x
Fort Sill OK	x	x	x
Fort Wainwright AK	Included in Richardson		
White Sands Proving Ground NM	x		
Fort Leonard Wood MO	x		
Yakima Training Area WA	x	x	x
Yuma PG AZ	x	x	x

Installation Summaries

For each installation, a short summary of the interviewer's evaluation of the installation's interest and potential applications is presented. The interview forms contain additional information that is not reflected in these summaries. Each potential use comes from a specific installation.

To determine which are the most commonly needed applications, the various verbal descriptions were all identified as one of 18 types, which were sorted and summarized in Table 2. Each potential use came from at least two installations.

The following sections contain individual descriptions from each installation survey. Application headings are presented in the same order as the frequency requests in Table 2. Many of these applications can appear under multiple headings. For the sake of brevity, they appear in this chapter only once; however, they are appropriately counted in the Chapter 3 analysis. Since many installations requested examples, illustrative images are included here wherever possible. The installations shown in the images do not necessarily relate to the particular installation requesting an application.

Table 2. Most frequently identified applications.

Application Frequency	Application
14	Vegetation and Trend Analysis
10	Habitat Conservation Management
9	Discovery of Unauthorized/Unrecorded Hazardous Disposal Sites
8	Archeological/Cultural Site Prospecting
6	Fire Modeling
6	Forestry Management
6	Support for Regional Ecosystem Management
6	Determination of Pre-deployment Conditions
6	Discovery of Former Training Range Types
5	Identifying Land Carrying Capacity for Military Usage
5	BRAC* Support
5	Erosion
4	Extending Management and Climate Change Trend Analysis Baselines
3	Subsurface Material Plume Detection
3	Water Resource Monitoring
2	Cost Effective Monitoring for Inaccessible Locations
2	Streamlining NEPA* by Supporting Adaptive Monitoring and Mitigation
2	Land Use Distribution Concerns

* BRAC = Base Realignment and Closure; NEPA = National Environmental Policy Act

Vegetation and Trend Analysis

- Wetland delineation
- Determining degradation or retreat of the tree line along natural corridors adjacent to river courses (see Figure 6)
- Tracking the spread of the sugar maple borer
- Assessing ice storm vegetation damage
- Desert vegetation trend change analysis
- Trend analysis to build a better record for comparison with present conditions

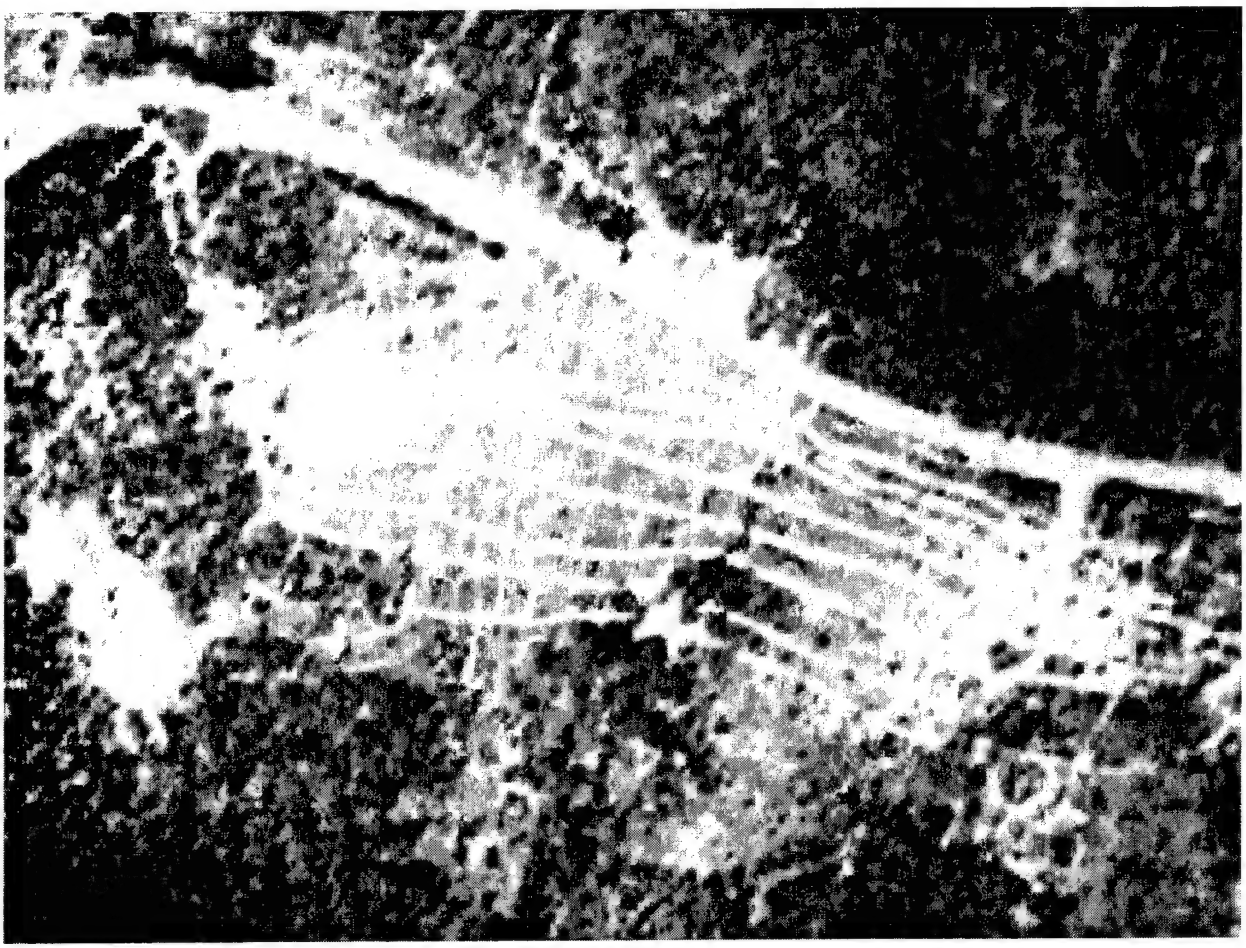

Figure 6. This 1964 image at Fort Benning, GA, shows tracked vehicle training areas and how a researcher may be able to follow forest edge changes.

- Access to archival information primarily for long-term baseline trend analysis — An example is using older imagery to identify locations where vegetation existed in the past but is not currently found. At the installation in question, a staff member pointed out images that are covered with white dots. It is known that the dots are not impact scars or Native American sites. These dots may indicate locations of past bush-type growth, which gathered litter and provided a milder microclimate for other flora and fauna (see Figure 7).

- Proving Ground land managers need to define vegetation distribution and type

- Using hyperspectral imagery to see if certain band ratios can be used to define the vegetation type more usefully.

Figure 7. South of Highway 51 at Fort Bliss, TX, individual groups of scrub about 11 feet across can be seen in this 1964 satellite photograph.

Habitat Conservation Management

- Vegetation/habitat mapping — Land managers need to know changes over time for purposes of vegetation change, noxious weed invasion, vegetation health, threatened and endangered species (TES) habitat, barren soil, and insect infestation.

- Identifying the direction of habitat trajectories from the change in vegetation cover

- Change detection for vegetation cover to determine TES habitat for Golden-Cheeked Warblers for nesting management. For this effort they believe they would need late 1960's data.

- Forest structure definition to help to design a monitoring inventory program for species such as the Goshawk and Spotted Owl

- Simple availability of large scale and regional data — valuable for purposes of reference to identify past occurrences and distributions of vegetation (and therefore habitat) (see Figures 8 and 9).

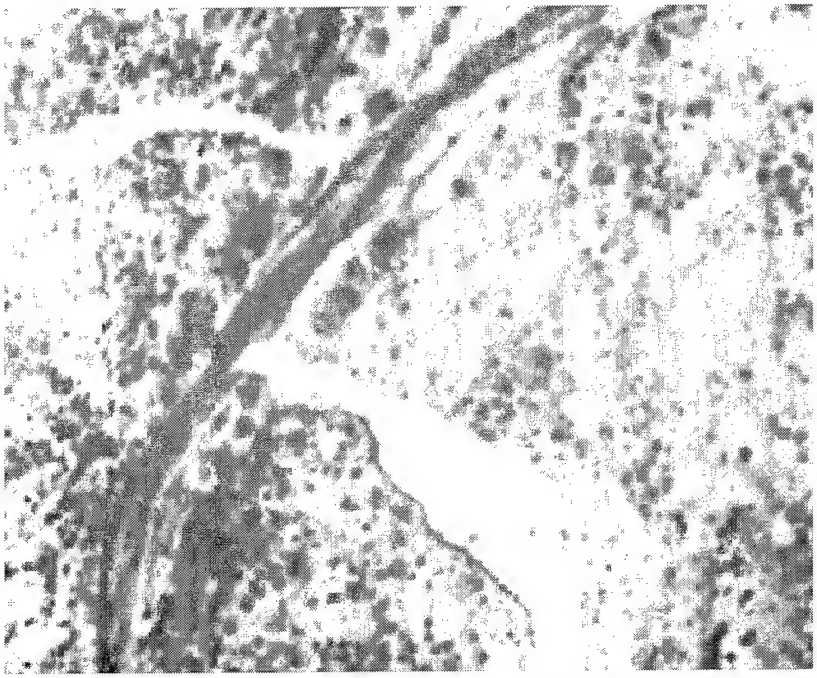

Figure 8. On this clear day in 1965, individual trees along the San Pedro River in southeastern Arizona can be identified and compared with the 1972 image in Figure 9. This image was taken from the same filmstrip shown in Figure 14, so this material serves both regional and detailed investigation needs.

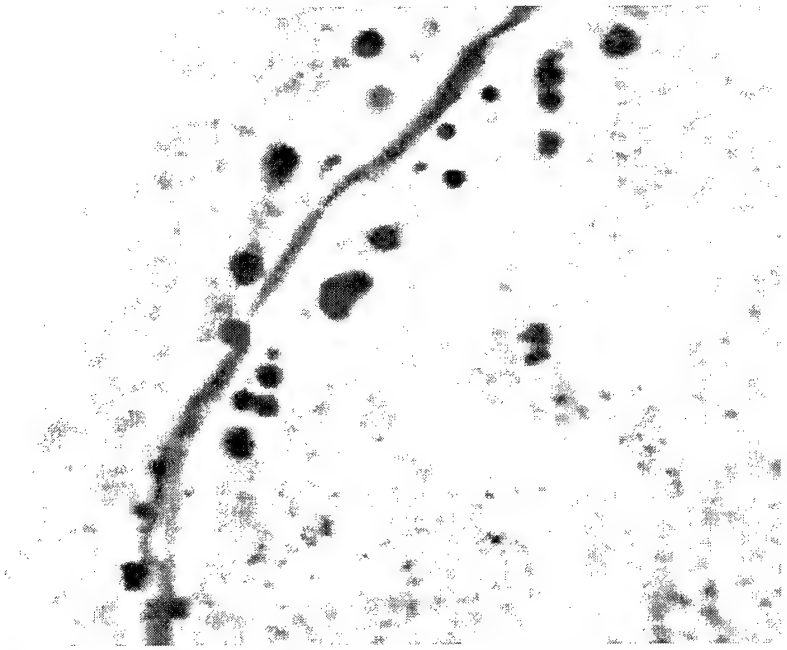

Figure 9. This image of the same area of the San Pedro 7 years later illustrates how orbital and atmospheric conditions can affect image quality. Still, individual trees can be identified.

- Identifying distribution of large patches of Agave over time. Agave is the prime food source for the Long-Nosed Bat, an endangered species. The purpose would be to determine stability in the population and refine Agave management objectives over the long term for fire prescriptions and biological assessment purposes.

- Identifying old burns ("Stand Replacing Fire") — Being able to draw the bounds of fires historically would be useful in determining TES habitat replacement and the degree and effect of TES persistence and reproduction.

- Habitat definition and monitoring, particularly for TES

- Defining Red-cockaded Woodpecker (RCW) habitat.

Discovery of Unauthorized/Unrecorded Hazardous Disposal Sites

- Landfills and training ranges

- Presence of abandoned landfills (chemical warfare material) — 14 sites have already been identified. However, panchromatic imagery (probably with a 1- to 2-meter resolution) would be needed to detect bulldozer tracks (Figure 10).

Figure 10. These multi-dividing trails may indicate the location of an old disposal site or land-fill in this May 1965 image at Fort Campbell, KY.

- Base cleanup operations — Transfer of an installation closed in October 1997 is pending the completion of remedial work. The Base Realignment and Closure (BRAC) Environmental Coordinator felt there were some potential applications of the declassified intelligence satellite imagery to base cleanup operations. One identified need is to locate an abandoned well that was filled in some time ago. It is in an area once used for chemical warfare training. They know the general area but do not have coordinates for the well. It was filled in during the 1970s so the archival declassified satellite imagery from 1960-1972 is of interest. The diameter of the hand-dug well is probably only a little bigger than a person, but possible fencing around the well may make the total area involved within the resolution range of the archival declassified satellite imagery.

- Location of hazardous waste sites — Circular testing sites or "grids" dating back to the 1940s are distributed all across an installation. These sites were used to test the dispersal characteristics of various agents. The location of many of these potential Solid Waste Hazardous Units (SWHUs) has been lost over the years and may pose hazards for training today. These disturbed areas can often be detected through patterned changes in the plant community structure. The difficulty in detection results from a lack of photographic data

in areas prior to testing or having data old enough to pick up changes that have since become obscured (see Figure 11).

- National Priorities List (NPL) cleanup — One installation used aerial photographs from the EPA's Environmental Photographic Interpretation Center as well as photographs from a local architectural and engineering (A-E) firm in their early preliminary assessment phases of investigation.

- Cleanup of lands formerly used by the military.

Archeological/Cultural Site Prospecting

- Cultural resource identification and site monitoring

- Identifying potential archeological locations

- A photographic history

- Land use distribution — Insecticide concerns are associated with some barracks demolished in 1965. Thus, photographs showing distribution of the old land use would be useful in locating the suspected structures and checking them for residual insecticide levels (see Figure 12).

- Archeological prospecting and management

- Support for the Cultural Resources Landscape Plan, which defines training area use over time

- Identification of archeological sites — The declassified images would provide key information (e.g., historic tree lines and fence lines) to identify additional significant home sites or foundations.

Fire Modeling

- Fuel load identification in arid areas where fire danger is greatest

- Definition of canopy closure for fire fuel characterization

- Back-model landscape changes via change detection and fire history analyses

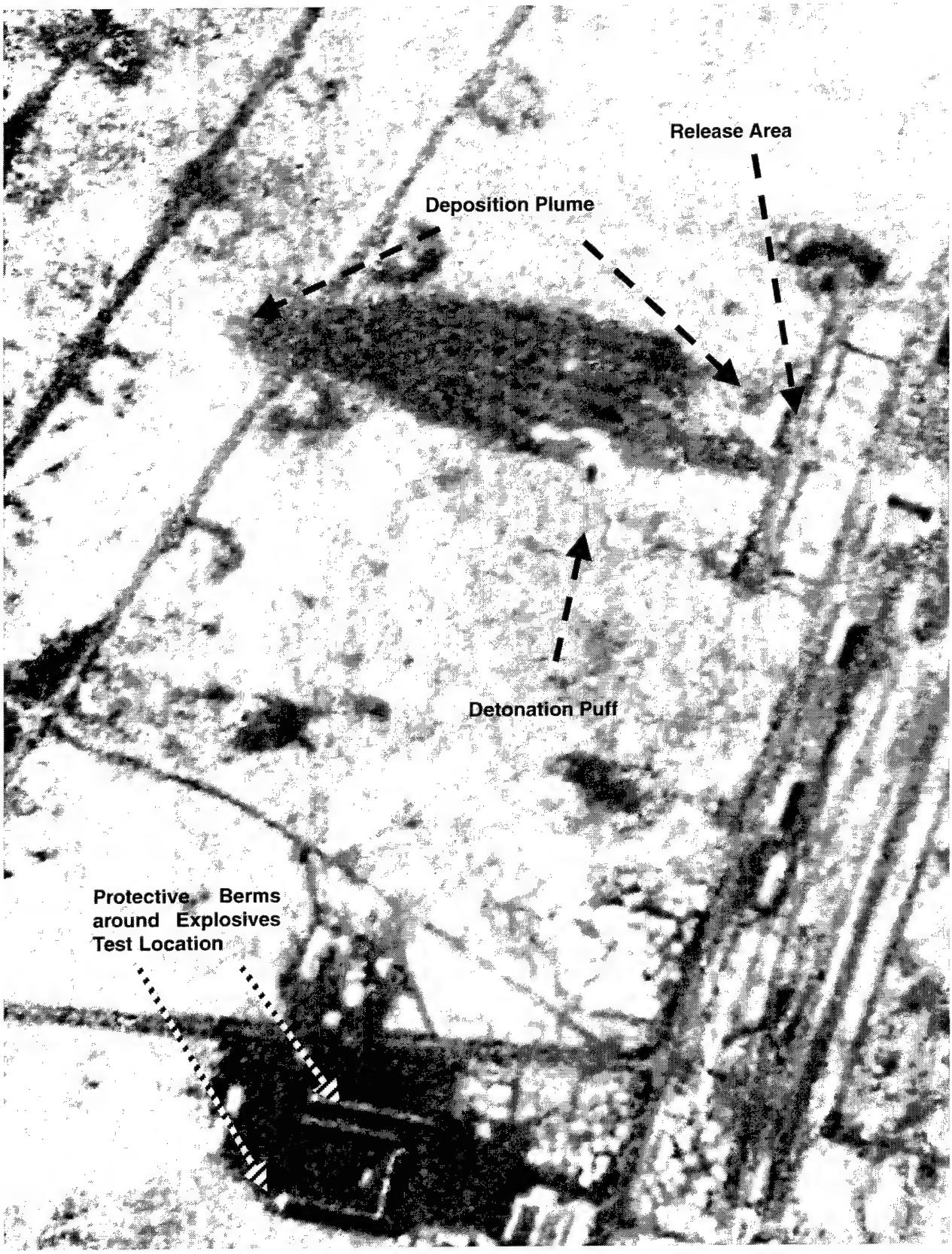

Figure 11. Deposition plume with an occurring detonation puff (center right) is captured in this 4 April 1967 photograph of the Dugway Detonation Site Complex in Utah.

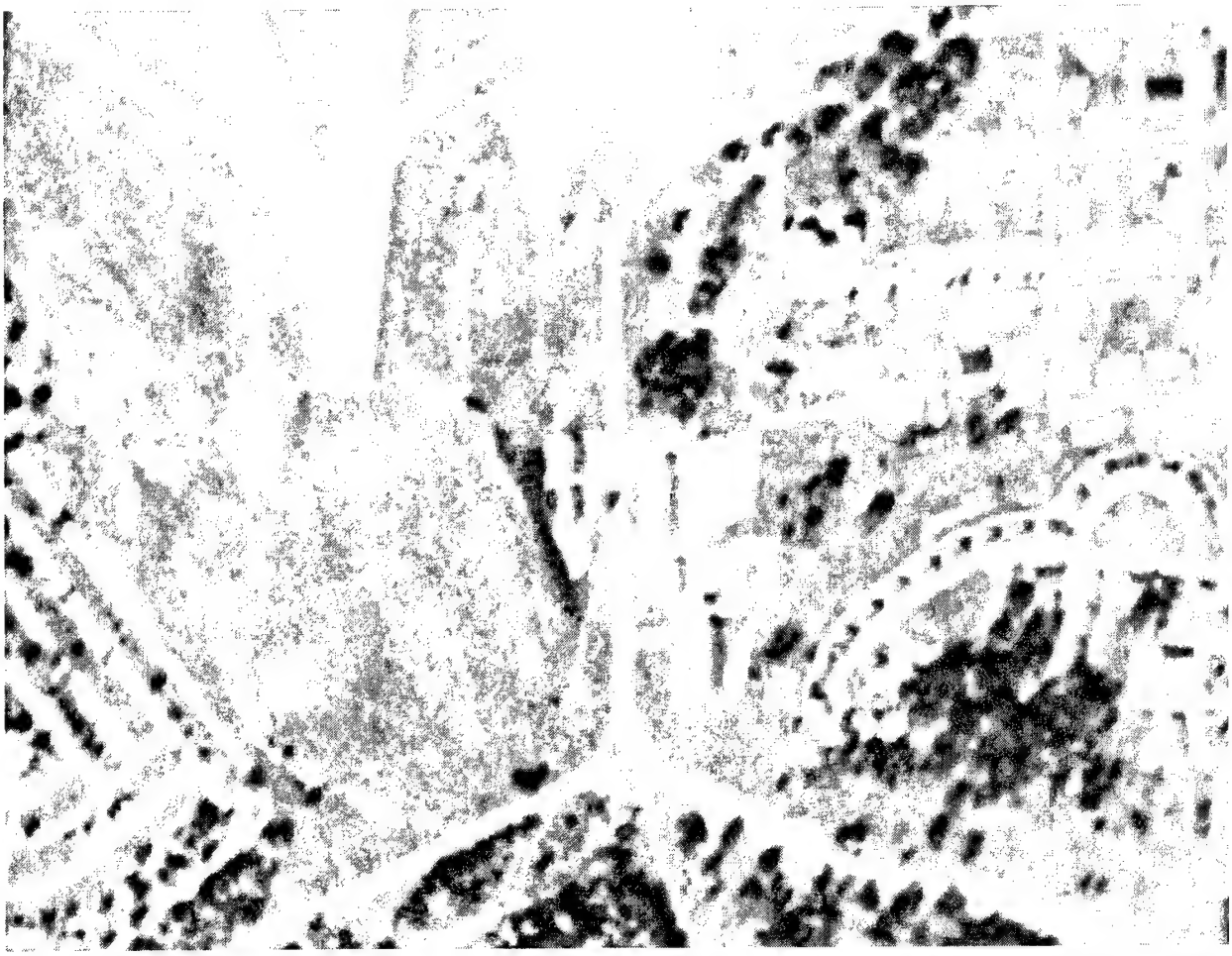

Figure 12. This image of the Fort Knox cantonment area shows barracks and house-size structures in 1964. The curved road defines a section of officer housing.

- Definition of woodland and grassland fire fuel distribution — specifically, distinguishing live versus senescent fuel accumulation would be used in the assignment of prescribed burning and pre-suppression planning.

Forestry Management

- Prescribed burns — In a quick turnaround format, it would be useful to tell how close crews are to the target burn prescription on a near-daily basis.

- Forestry management actions, particularly in relation to the identification of stand health

- Study of pine stands versus open fields using the archival information

- Change detection for Forestry Office activities and for wildfire/prescribed burns

- Monitoring stress due to pine beetle infestation
- Monitoring stress due to aggressive non-native tree species
- Pattern assessment — Depending on the frequency of images for a given period of time (e.g., months or days), photographs may be used to assess patterns for prescribed and accidental burns.

Support for Regional Ecosystem Management

- Regional ecosystem management — includes defining and limiting the extent of legal and financial liability for the impact that an installation has within a regional context (see Figure 13).

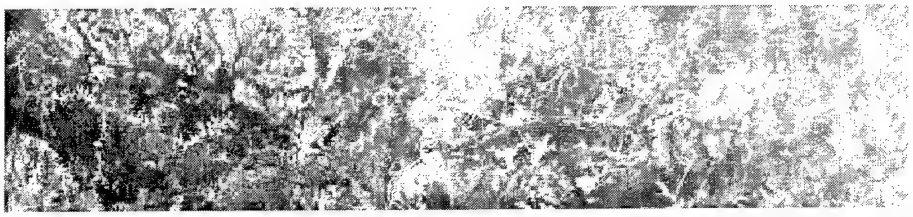

Figure 13. Installations may be concerned about limiting their and DOD's liability for environmental impacts within the region. This 1964 image (which includes Fort Benning) covers over 1,000 sq mi and can set the regional context.

- A great baseline of data for trend studies — The imagery could also provide some insights as to impacts both to and from the surrounding areas.
- Regional ecosystem characterization over time (see Figure 14)
- Region-wide desert ecosystem mapping

Determination of Pre-deployment Conditions

- Comparing the condition of the maneuver site prior to the Army's acquisition in the early 1980s (see Figure 15).
- Trend comparison — The burn plans used at the installation over the years may be affecting woody cover on the ranges. Historic aerial photographs would provide a baseline from which to monitor the trend.

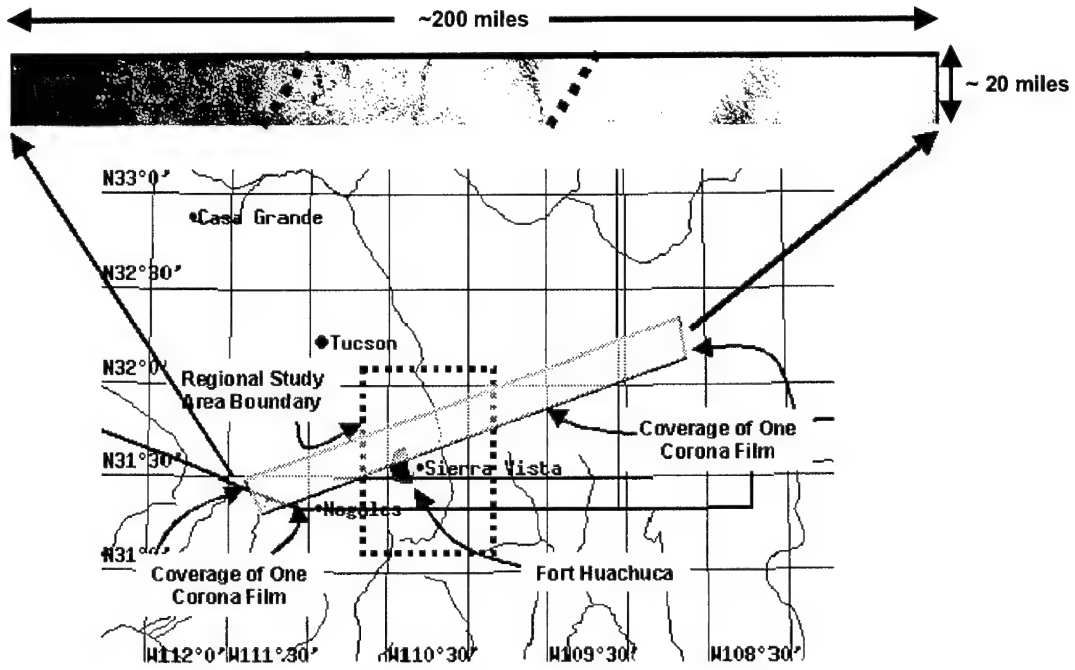

Figure 14. At roughly 3,300 square miles, the coverage of a single image at high resolution is tremendous. To cover the area for this regional ecosystem study around Fort Huachuca, AZ, would take thousands of air photos. Here it takes less than seven images.

Figure 15. This 1964 image of the Pinyon Canyon (CO) Area, taken 20 years before military use began, shows how sensitive the land is to erosion.

Discovery of Former Training Range Types

- Locating landfills and training ranges

- Searching for abandoned ranges — Locations and extent of old ranges are not well known. The older 1960s imagery may provide clues as to where to search for abandoned ranges. Currently cleanup requires a 100 percent survey for Formerly Used Defense Sites (FUDS) at a cost of $10,000/acre. Focusing in on particularly likely areas could decrease search costs and increase the quality of the survey.

- Identifying historical land use — Generating geographic information system (GIS) layers of historical ranges, historical land use, and land condition trend analysis (LCTA)

- Defining areas for forestry management — Former ranges used live ammunition that contaminated trees with bullets. These bullets would ruin pulpwood equipment, so the staff is interested in defining old range and firing lines.

Identifying Land Carrying Capacity for Military Usage

- Identifying insect infestations early would allow direction of insecticide spraying on small areas of the installations

- Identifying long-term degradation of the training area quality

- Determining the suitability of different sites for new multipurpose range complexes

- Determining if land management practices over the years have improved land conditions

- Detecting change in areas used for training activities

- Quantifying acres of bare ground — specifically with recent imagery before and after training rotations.

- Detecting potentially hazardous areas for training — Cheatgrass (*Bromus tectorum*) is an invasive exotic species that has overrun 65 to 70 percent of disturbed (i.e., training) areas on the installation. The loss of native vegetation increases fire hazard on the ranges because Cheatgrass burns more

readily than native plant materials, which leads to more extensive range fires. Subsequently Cheatgrass encroaches. Loss of sparse trees for tactical concealment and pristine canyon vegetation makes this species a mission capability concern. Cheatgrass encroachment has considerable impact on both training and environmental concerns.

- Training restoration and management

- Land condition before and after military exercises — Installation personnel felt they needed to build up archives to include aerial image data from 20 to 30 years ago (see Figure 16). These data would be very useful for change detection analyses to monitor maneuver-related damage over time. This monitoring is critical for proper land stewardship. They are currently using SPOT data (30-meter resolution) for land use classification mapping. The 9-foot resolution of the declassified and perhaps classified imagery would be helpful in discrimination and interpretation of land use and cover types.

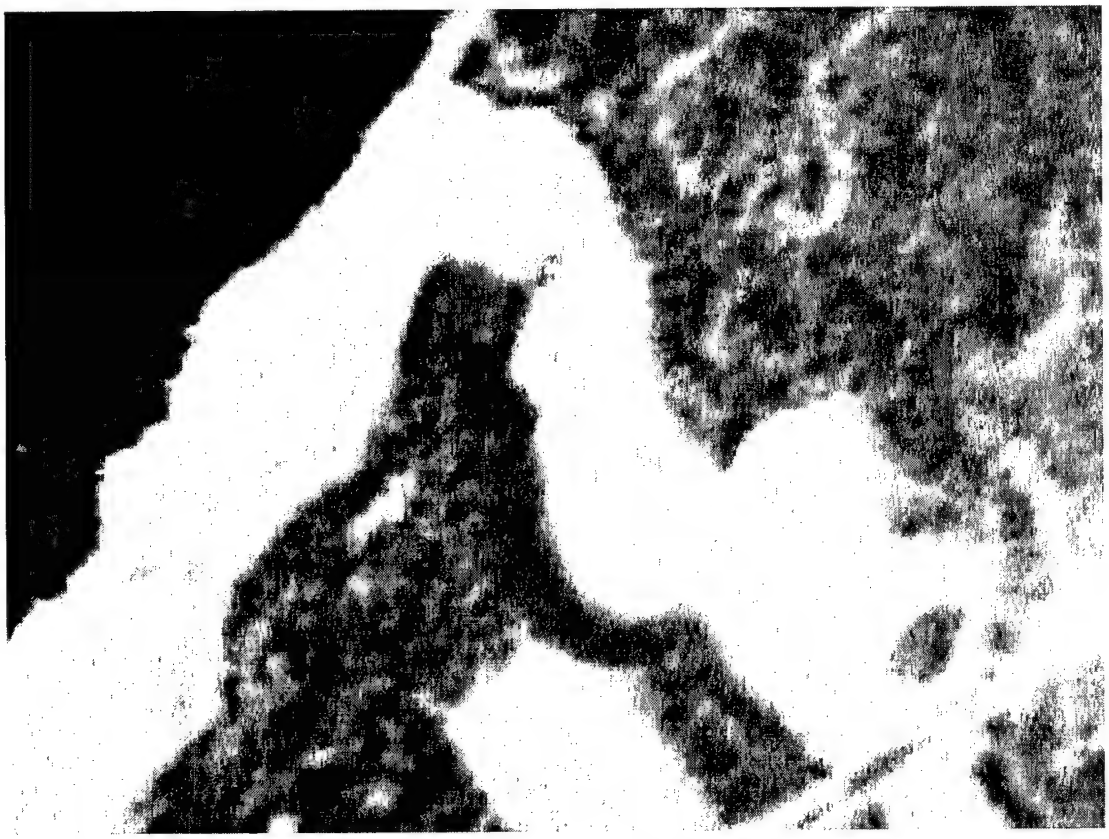

Figure 16. This 1972 image taken near Fort Richardson, AK, shows the edge of the tree line adjacent to a river wetland.

- A carrying capacity matrix via digital processing
- GIS system data support for training areas and ranges
- Change detection analysis — Since maneuver area tactics are transitioning from the use of stationary firing points toward a "shoot and scoot" approach, training land damage is likely to increase. Change detection analyses would be important to monitor specific training impacts.

BRAC Support

- Capped wellhead protection/monitoring — Though restrictions vary for each state, long-term monitoring is required even if the Federal Government no longer owns the land.
- Land acquisition proposal development and tracking
- Surveying — A portion of the Tropical Test Center (TTC) may be moved. In case a need arises to determine the location of the TTC, there is or will be a need to generate digital elevation models (DEMs), infrastructure, imagery, hyperspectral, and other data for these areas.

Erosion

- Shoreline changes at the landing sites for bivouac training
- Land surface and gully erosion identification (see Figure 15)
- Changes in the movement of gullies, wetlands, woodlands (expanding, receding, or thinning)
- Shoreline erosion along the Chesapeake Bay (see Figure 17)
- Definition of grasslands — The imagery would provide a large-scale snapshot in time to help identify emerging areas of erosion problems.
- Dust abatement management
- Erosion control/revegetation monitoring (see Figure 18)

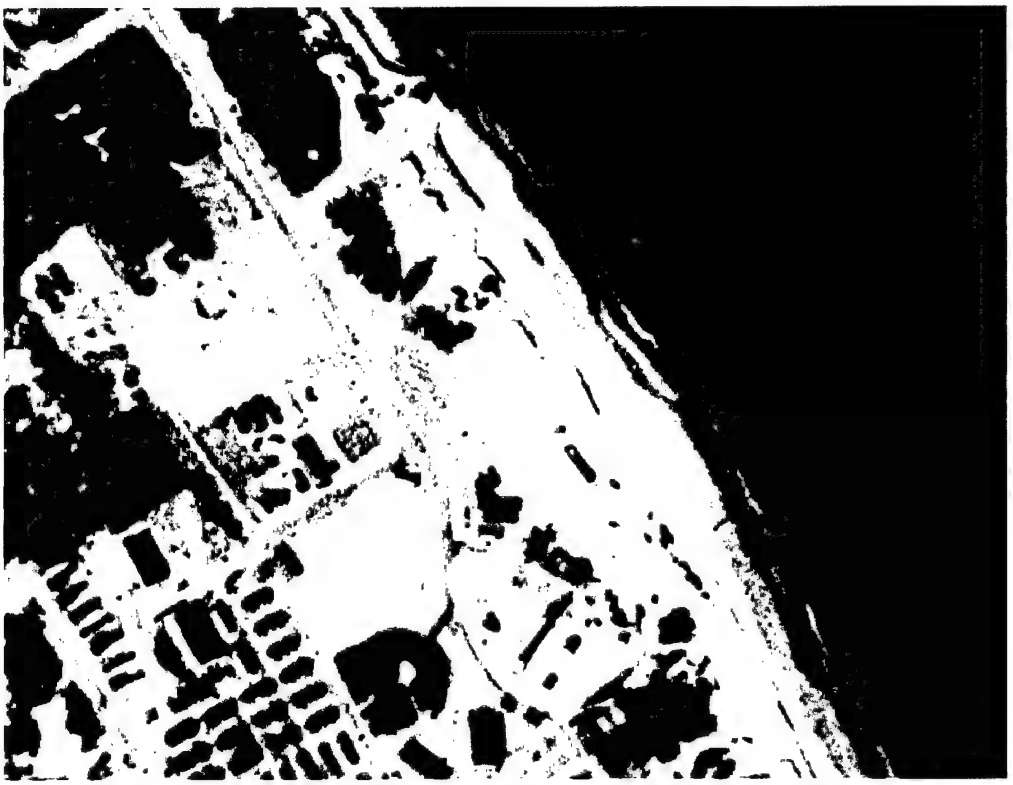

Figure 17. Beach areas such as this at Fort Story, VA, on 26 December 1963 are where Logistics Over the Shore (LOTS) training occurs.

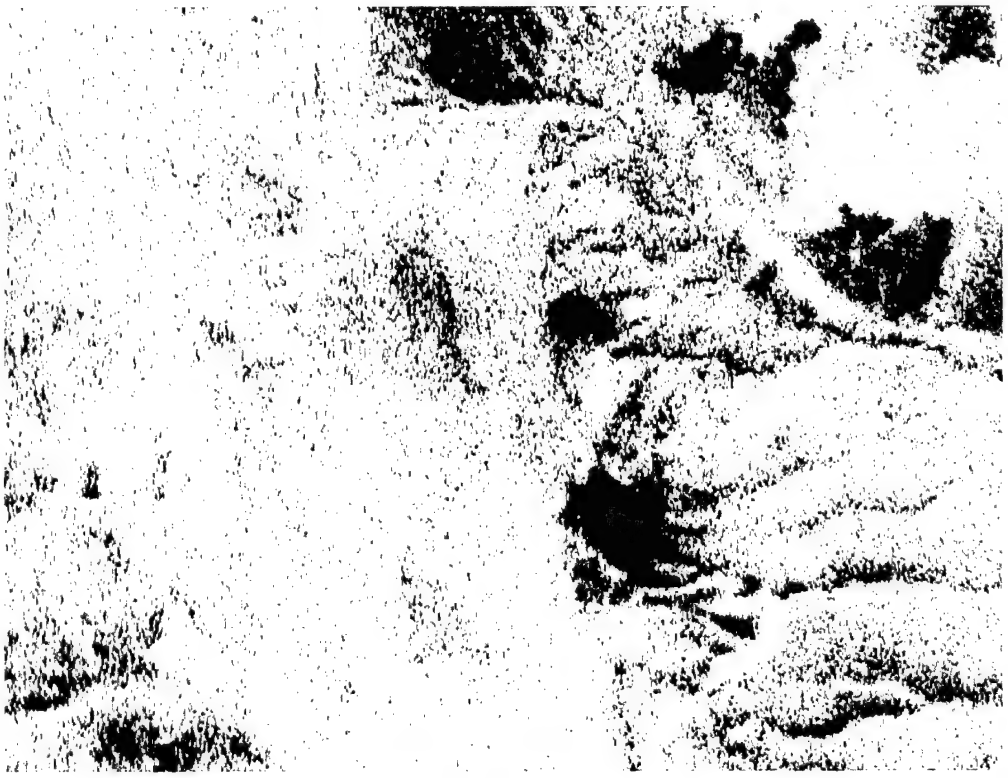

Figure 18. This 1964 image of Fort Irwin, CA, shows the barren land surface that requires erosion management and dust control.

Extending Management and Climate Change Trend Analysis Baselines

- Ecosystem health risk — Both archival and future imagery would be useful in identifying regional change trends in the ecosystem and in objectively determining the military's contribution to the trend, potentially saving some expense by documenting and limiting the military responsibility.
- Extending imagery coverage already in place at the installation
- Monitoring stress due to drought
- Defining vegetation trajectories to support the evaluation of increasing aridity (Figure 19).

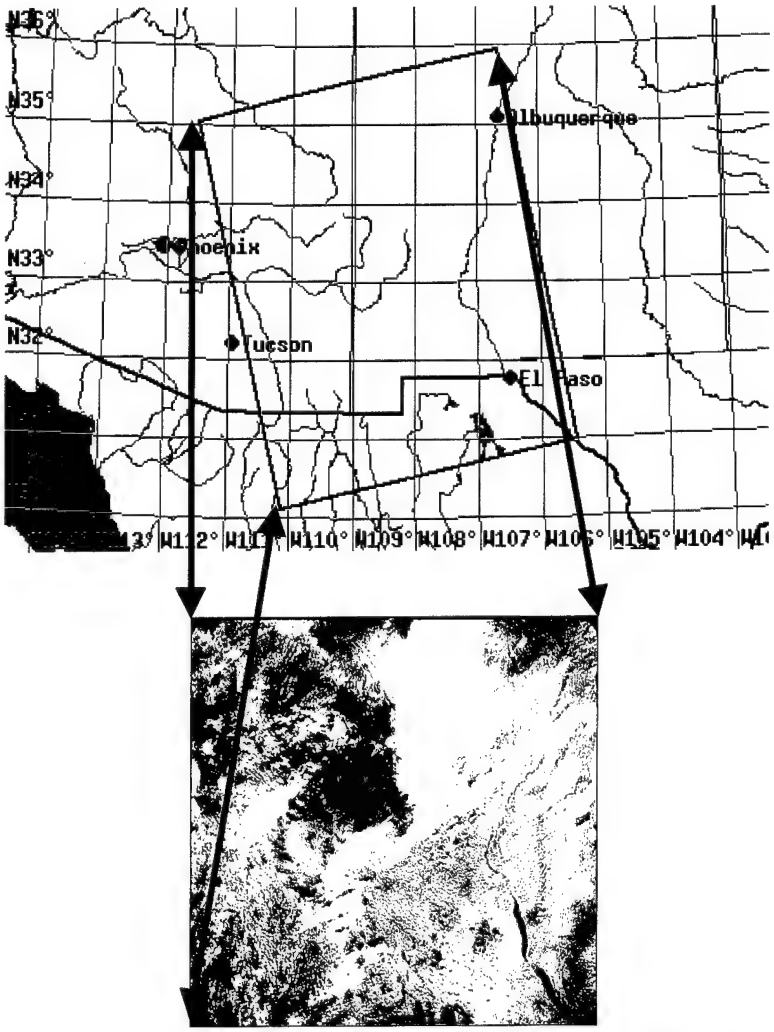

Figure 19. Film-based imagery is available from the late 1950s to about 1963 in about 1-km resolution. This single film includes White Sands Missile Range, Kirtland AFB, Holloman AFB, Sacramento Peak Upper Air Reserve, Fort Bliss, Fort Huachuca, and part of Davis Monthan AFB. Such images could serve as a good base for climatic change or cumulative impact studies.

Subsurface Material Plume Detection

- Historical contamination — Anecdotal evidence suggests undocumented waste was buried in what is now considered an unacceptable manner. Archival photography might help to locate historic landfills.

- Discovery of old landfills and dumps (see Figure 10)

Water Resource Monitoring

- Water quality issues in the western United States — Determining the effects of installations on the water quality (heat loads, contamination, siltation/sedimentation loads) would be very useful to follow changes, particularly in a near real-time format.

- Spring and riparian vegetation monitoring

Cost-Effective Monitoring for Inaccessible Locations

- Restoration — Though most locations are well along in the restoration process, the military must ensure that no new leakage appears, even after the land is turned over to other agencies or civilian usage. Therefore, a 5-year frequency-monitoring program would be a good means to follow the status of the buried materials, particularly in areas that are relatively inaccessible.

- Monitoring inaccessible TES sites

Streamlining NEPA by Supporting Adaptive Monitoring and Mitigation

- Temporally repeating (5-year cycle) reevaluation

Land Use Distribution Concerns

- Identification of trends and possible land use incompatibilities through land use and vegetation change over time

- Grazing impacts

- Verification of GIS layers already in place

- Historic land use patterns

- Change detection analyses of training areas on post.

Installation Success Stories

Not only are installation land managers interested in using the resources, some have taken the initiative to acquire and apply them to specific questions. This section highlights those activities at installations that can be considered positive and ongoing uses of the imagery resources available.

Dugway Proving Ground (DPG)

DPG is making substantial progress in detecting potentially hazardous areas for training. DPG staff became aware of the availability of declassified satellite imagery by exploring the United States Geographic Service (USGS) Global Land Information System (GLIS) website. Using the service, they ordered strip negatives and film positives covering the aerial extent of DPG lands from 1962 to 1969. These films were scanned on post at an optical resolution of 1200 dpi. At this resolution many previously unknown test grids were detected. Circular testing sites or "grids" are distributed all across the installation and date back to the 1940s. These sites were used to test the dispersal characteristics of various agents. The location of many of these potential Solid Waste Hazardous Units (SWHU) has been lost over the years and may pose hazards for training today. These disturbed areas can often be detected through patterned changes in the plant community structure.

DPG staff are also able to bolster their efforts to monitor and predict the encroachment of Cheatgrass that has considerable impact on training and environmental concerns alike. Cheatgrass has overrun 65 – 70 percent of disturbed (i.e., training) areas on the installation (Figure 20). The concern involves not only the loss of native vegetation, but also the increase of fire hazard on the ranges. Cheatgrass burns more readily than native plant materials and leads to more extensive range fires. Additional native vegetation is subsequently lost, which allows the encroachment of more Cheatgrass. The loss of already sparse trees for tactical concealment and pristine canyon vegetation makes this encroachment a problem of great concern. Trend analyses for prediction purposes cannot be completed without accurate data from the past. Naturally, the more data points available the better prediction capabilities become. Because of the increased resolution available and the relative ease of use, Dugway has made substantial progress in detecting potentially hazardous areas for training.

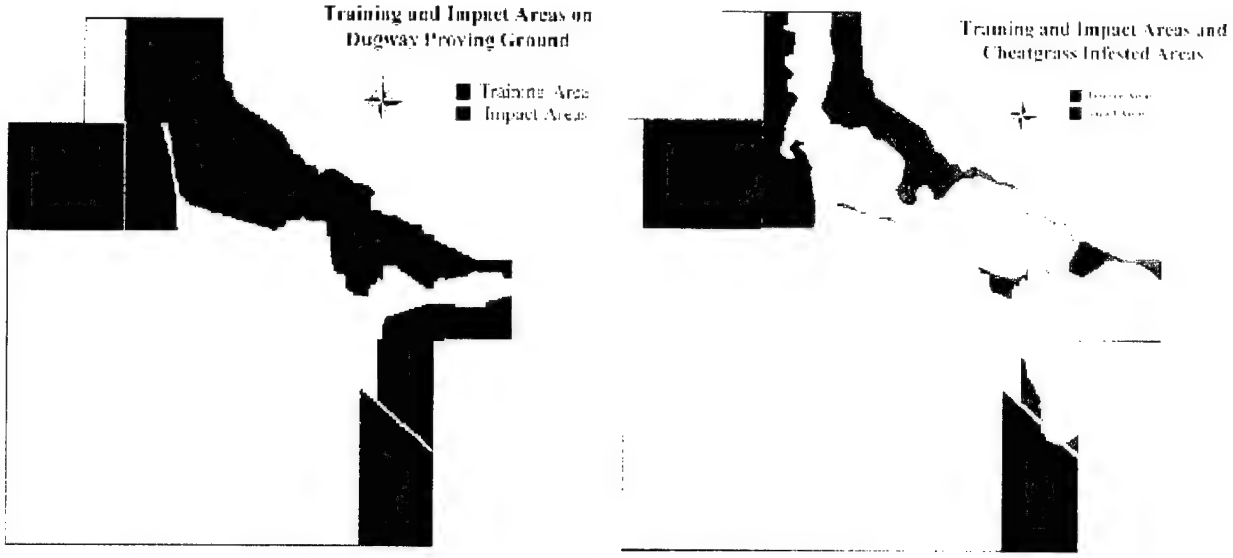

Figure 20. Infestation of Cheatgrass over a large portion of the training areas (right in yellow).

Fort Huachuca

At Fort Huachuca the "Predictive Knowledge Based Modeling of Vegetation Patterns" project, is being carried out through the Engineer Research and Development Center's (ERDC's) Topographic Engineering Center (TEC) in cooperation with North Carolina State University. The purpose is to develop and validate statistical models of vegetation type and structure and to integrate the model results into a knowledge-based image processing system for wider potential user community. In this imagery, terrain and field observations are integrated into a GIS database. Related characteristics are statistically modeled to build a knowledge base. A terrain analyst reviews the result and generates a feature database. Fort Huachuca was chosen because of its diverse vegetation (grasslands, shrublands, woodland, and forests), which responds to the significant change in elevation. The vegetation is critical to both watershed health and wildlife habitat. Further, human disturbance of the vegetation community has been limited this century, which to a large extent reflects the environmental gradients of light water and nutrient availability. High-resolution imagery was originally one of the components to this work. Though this project is ongoing, the data and algorithms do not reside at the installation itself and they are unlikely to in the near future. This work is potentially useful for Integrated Training Area Management (ITAM) work in the Land Condition Trend Analysis (LCTA) program plots. The purpose of these program plots is to follow changes on the installation lands through field surveys. Decreasing the cost of the field surveys through the use of imagery analysis would benefit the military.

A related project carried out by TEC and the University of Arizona was called "Remote Sensing and GIS Techniques for Fuel Load Mapping and Fire Spread Modeling at Fort Huachuca AZ." Fire fuels in forest ecosystems of the southwest have accumulated to high levels because of strict fire suppression policies. To plan prescribed burns effectively, it is important to determine the amount of the fuels in a given area. This project used on-the-ground surveys in conjunction with GIS layers (elevation, vegetation, etc.) and civilian and high-resolution imagery to determine the amount of fuel material present in Garden Canyon (Figure 21). With this background, fire spread simulation using a modeling program called FARSITE was carried out. This information was integrated into the new fuels data for the Fort Huachuca fire management plan.

Both projects at Fort Huachuca have decreased their dependence on high resolution imagery because of the difficulty of obtaining and manipulating the material.

Fort A.P. Hill

Imagery test case techniques using different sensors were applied at Fort A.P. Hill, VA. In this study, National Technical Means (NTM) data (both archival and newly collected image resources) are compared with the usefulness of airborne Digital Multispectral Video (DMSV) sensors to map vegetation. Vegetation attributes that were generated include: forest types, percent canopy closure, stem spacing, and tree height. For estimating forest type and other attributes the research evaluated (1) NTM alone, (2) NTM merged with DMSV, and (3) DMSV alone. NTM resources were enhanced by the addition of the DMSV spectral information. In addition, the utility of using archival NTM in analyzing temporal change on an installation landscape over time was evaluated. Emphasis was placed on areas of documented disturbance history. It should be noted that the availability of archival NTM imagery over a particular location varies greatly. Though the techniques are classified, the installation does have some of this information.

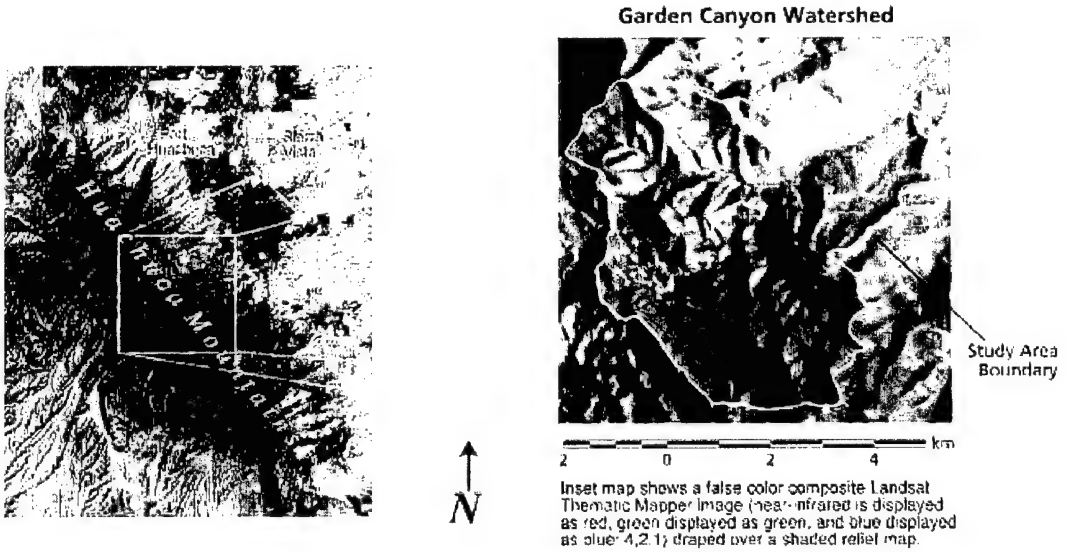

Figure 21. Location of the fire fuels project at Fort Huachuca.

Fort Hood

Fort Hood was overflown in May 1995 by several coordinated sensing systems (civil and classified, airborne and satellite) in a short period of days. Project Sensor Optimization, sponsored by the National Reconnaissance Office (NRO), intended to identify the most desirable individual and combined retinue of instruments to generate land character information. Both spectral and topographic (through the Interferometric Synthetic Aperture Radar [SAR] for digital terrain Elevations [IFSARE]) data were acquired. One item investigated was how to combine sensor data to generate data that were not available from the individual sensors. For example, areas in shadow may appear to be water, though they are not. Combining different sensor data corrects for this problem. This project is now complete. Much of the data resides at the installation in the G2 office of 7th Corps.

Fort Irwin

Fort Irwin has been in the forefront of classified imagery applications by developing a large depository of imagery (both civil and classified) as part of the Mojave Desert Initiative. Several studies dealing with a TES and vegetation analysis (Figure 22) have been carried out through TEC. The vegetation analysis was part of the GATF efforts in the initial applications of NTM imagery for use in environmental evaluation. The "GIS-Based Modeling of Desert Tortoise Habitat in the Mojave Desert" (http://asio.jde.aca.mmu.ac.uk/new_gis/Tortoise/rep1.htm) is another project dealing with this subject. Natural resource managers responsible for endangered species management can benefit from GIS-based wildlife

habitat models. On that premise, a geospatial habitat model of a Desert Tortoise population on the National Training Center (NTC) at Fort Irwin is under construction. The model's function is to statistically relate field mark-and-recapture tortoise data to GIS layers on plant communities, soils, topography, and geology. The primary data sources for the project are remotely sensed imagery (including high-resolution imagery), GPS survey data, and field transect data. Organizations participating in the project include the National Park Service, Natural Resources Conservation Service, NTC, and members of the academic community.

Fort Benning

At Fort Benning TEC carried out a Legacy project that used NTM resources integreted with civilian imagery in a GIS to identify forest communities suitable for Red-cockaded Woodpecker habitat. The results assist Fort Benning resource managers in developing new management plans for the protection of this endangered species.

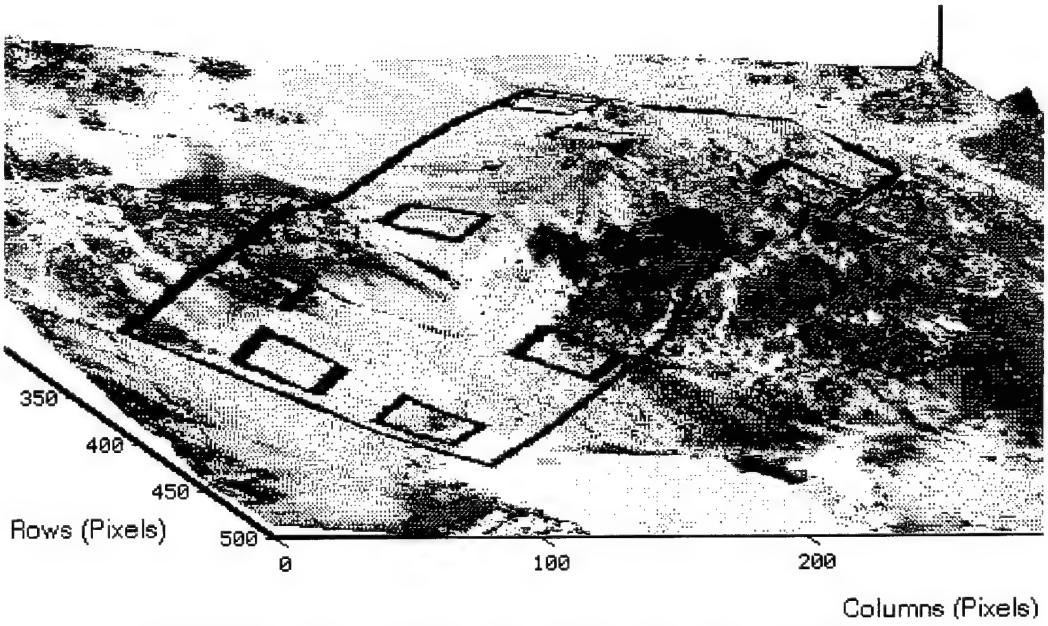

Figure 22. 3-dimensional view of northern Alvord Slope, Fort Irwin, CA. This image shows the study site boundaries and study plots where vegetation and desert tortoise surveying were completed in Spring 1995. North is in the direction of the y-axis.

Yuma Proving Ground

The GIS Group at Yuma Proving Ground (YPG) has used NIMA products (acquired through Space Command). These include 160 USGS Ortho photo quadrangles (Figure 23). The latest imagery was acquired in 1996. Also acquired was a 30-meter Digital Elevation Model (DEM) data set. The purpose is to do real time 3-D simulation with information directly from Proving Ground site-implaced sensors based on a Controlled Image Base (CIB).* NIMA products are supplied without charge to customers in a "theater of action" status. Since installations are not in this status, they must pay for their NIMA products. Synthetic Aperture Radar (SAR) and Hyperspectral missions have been flown over the installation, but the imagery from those has not yet arrived at the land manager's offices.

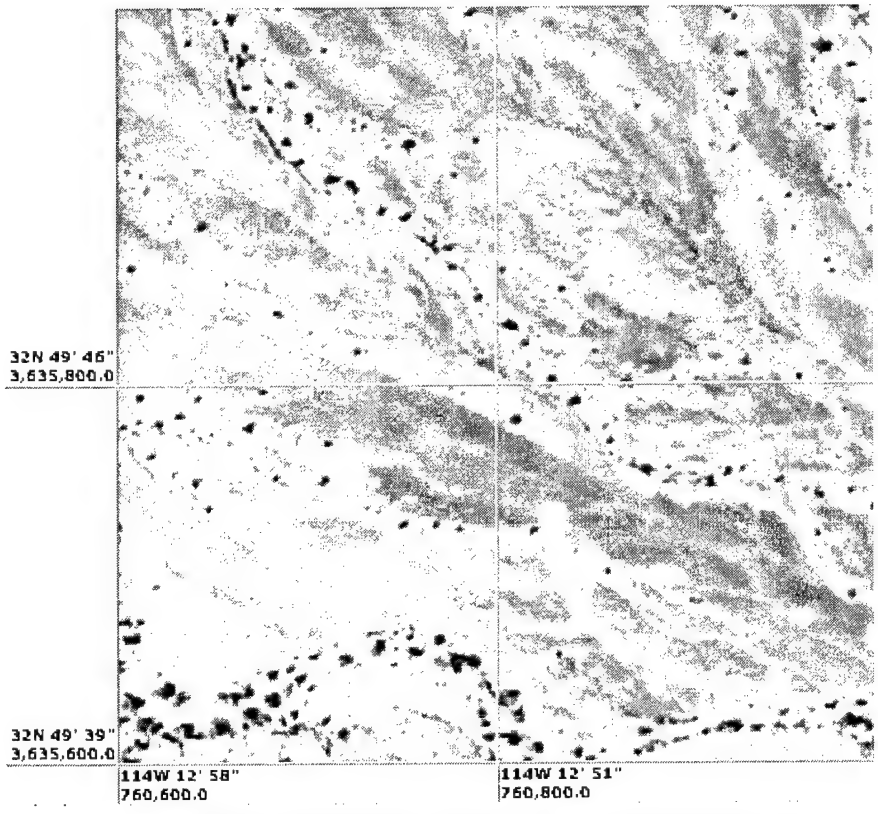

Figure 23. USGS Ortho Image at Yuma Proving Ground.

* For NIMA, a Controlled Image Base (CIB) is a dataset of orthonormalized and rectified grayscale images. CIB data are produced from digital source images that can be converted to meet the requirements defined in MIL-STD-2411-1. CIB data are derived directly from digital images, and are often compressed and reformatted to conform to the RPF Standard.

Fort Lewis

At Fort Lewis WA, the GIS and imagery staff have good facilities and are advanced in their usage of imagery (see Figure 24), including classified material.

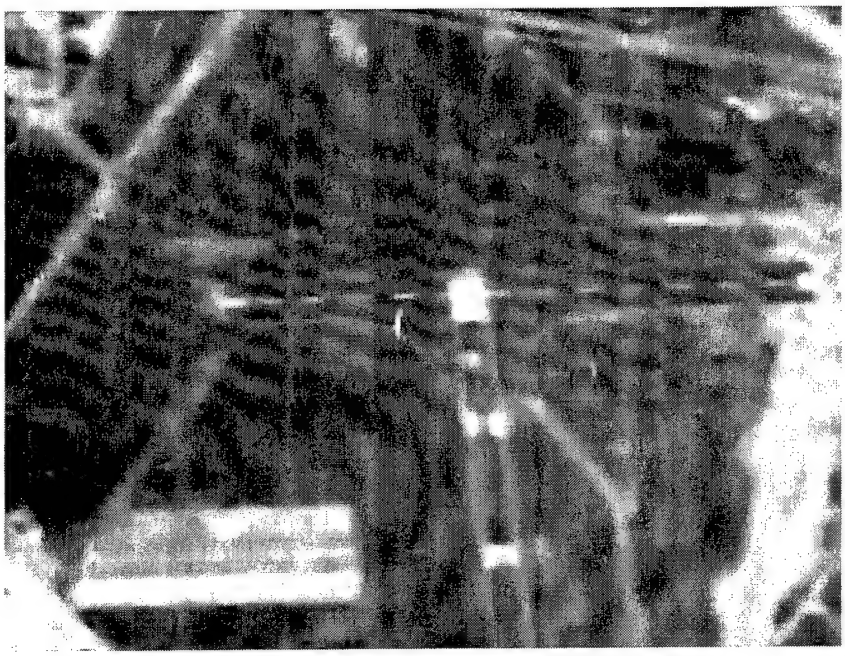

Figure 24. A landing strip at Fort Lewis in 1970.

Applications Survey Summary

Several generalizations can be made from the interview results. The more an installation has used imagery in the past, the more important its use becomes. This is particularly true for those who have used declassified imagery and even more so if they have made an effort to use classified imagery.

Installations often know about missions being flown by the classified community and know that the resource exists. Usually, however, the staff has not benefited from using the imagery for ongoing land management programs.

Clear examples of how the data can be applied would help expand its potential usefulness:

- by seeing some examples
- by having a list of what exists, specifically for their installations

- by using vegetation character to help define habitats, particularly for TES-related purposes.

A difficulty of perception rather than reality seemed to exist. If an installation had not developed a relationship with their resident imagery-handling support group (the intelligence unit at the installation), the setup effort appeared to be a great obstacle to overcome. Once established, however, the support was commonly considered "business as usual."

In many cases, the sense of the researchers surveying installation personnel was that:

- They responded with potential applications for which they had the "hottest" current need. As this summary indicates, some applications were common across many locations.

- Not mentioning a potential application did not mean it was not useful, but that it was not at the top of a very long list of issues with which the installation personnel needed to deal. For example, if a BRAC installation was called, BRAC was the most important issue rather than training or land monitoring. The samples in this survey include a very limited number of BRAC locations, but the enthusiasm for use of this material was usually high, even though the number of "hits" in the matrix was low.

Many installations expressed an interest in "getting their feet wet" using the archival imagery for historical purposes, often by simply looking it over (Figure 25). Their view was to go slowly with minimal initial effort and put more resources toward it once it proves its value for simple initial applications.

Though many installations expressed an interest in higher resolution imagery, 1- to 4-meter resolution is probably sufficient for most natural resource management purposes. The 1999 launch of commercial nonclassified satellites fulfills this need without requiring a clearance. This implies that the Federal Government's archival data (unclassified or otherwise) represent a resource available from nowhere else.

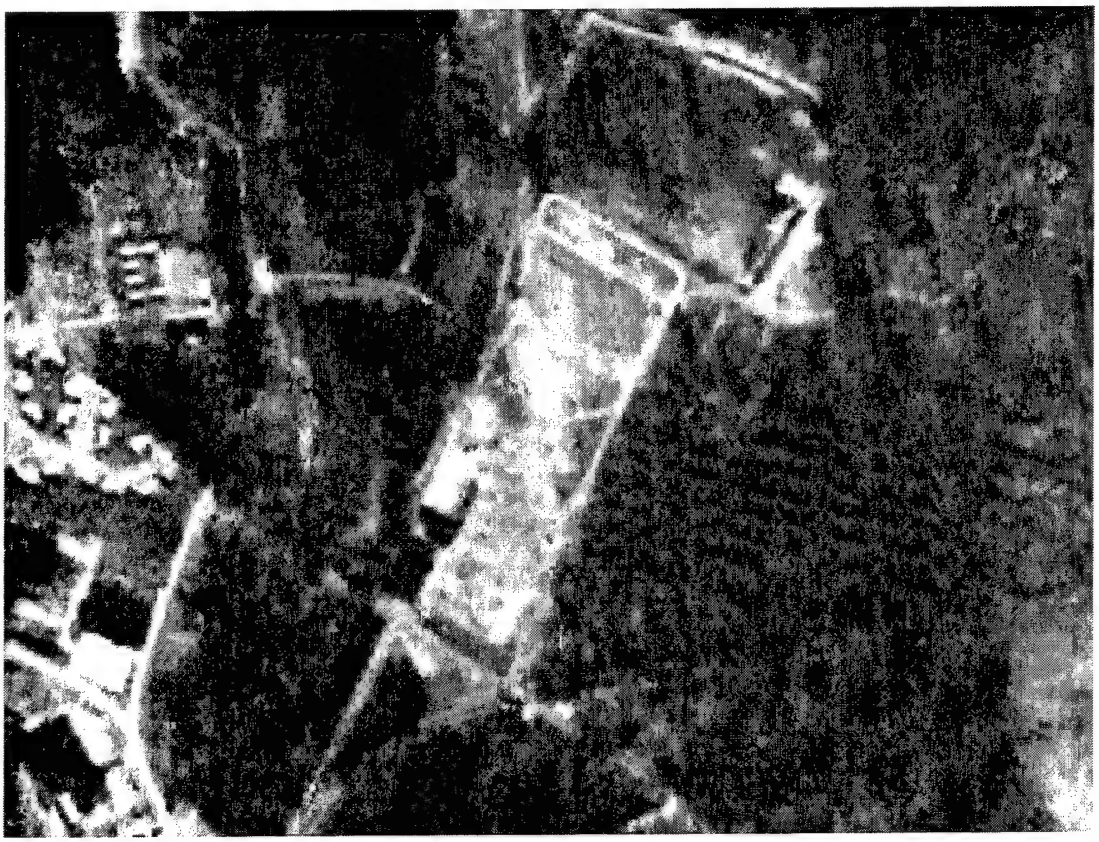

Figure 25. Making available more example images such as this 1964 image at Fort Eustis, VA, would increase land managers' interest.

After unclassified 1-meter imagery is available, the new questions include:

- How much better is the classified imagery?
- Is it worth the extra effort in acquisition and handling for the user's need?
- What is the comparative price? (Will government sources be less expensive?)
- Will the civilian imagery include all spectral areas or might some information still be available only within a classified source?
- What are the applications that may require spatial resolution greater than that available commercially?

It was often true that the larger the installation, the more often all types of imagery were important in land management. This is simply a result of the larger installations being too big to even begin to manage by onsite investigation only.

This survey emphasized the black and white 1960's archival imagery, because those were the examples at hand. Other imagery that could not be discussed over the telephone might answer installation questions more adequately. Use of panchromatic imagery was simply a limitation of time and the means of communication. This issue is addressed, largely through the application of "best professional judgement," based on the discussion in the limited-distribution appendix to this report (see footnote on page 15). However, the apparent emphasis on the panchromatic images is likely to have limited the responses as to the potential applicability to their installation problems, especially for those installations not familiar with the classified imaging capabilities (called National Technical Means – NTM). In addition some installations quickly lost interest in the discussion because the 1960's imagery was too old for land management purposes and too new for cultural resources applications. However, other installations indicated that this time horizon was opportune.

3 Analysis of the Army Installation Surveys

The purpose of this effort was to provide an objective evaluation of the highest payback for applications extracted from this work. For that purpose, a queriable digital matrix was developed using the Microsoft® Access Data Base Management System. Most of the raw data from survey forms were inserted into the data base. In addition, several of the fields were numerically summarized so that the content could be manipulated to objectively answer the critical questions toward which this work was directed. In each case:

- a question is posed
- the matrix query results are presented in order from "very high" to "no response" among the installations surveyed
- a descriptive answer is presented in separate **Conclusion** and **Recommendation** sections.

Level of Installation Interest

Comments from the installation staff's expressed level of interest in the imagery were reviewed and, for each installation, a relative rating was given — 1 was "high"; 4 was "not interested." Table 3 summarizes these ratings.

Table 3. Interest expressed.

Interest level	Number of installations
High	17
Moderate	0
Low	3
Not interested	2

Conclusions — Of those installations responding, most can be identified with a high level of interest in the potential applications of the declassified imagery, as presented to them with the material provided in Appendix B. Since the survey, better illustrative materials have been developed, so these results probably represent a minimum level of interest. At a minimum then, the installations surveyed overwhelmingly expressed interest in the potential that this imagery may hold for them.

Recommendations — This overwhelmingly positive response strongly suggests that materials should be supplied to the installations surveyed.

Most Commonly Needed Applications

By far the most common imagery applications that these installations expressed a need for deal with the identification of vegetation (i.e., land cover) and the changes that take place in vegetation over time. In fact this preference is to be expected, as many of the other applications are simply the use of land cover type as applied to other questions. Of these other questions,

- Many installations were interested in finding all types of lost hazardous disposal sites

- Habitat conservation — largely a matter of identifying the cover type appropriate to a species of concern to ensure some degree of health and distribution

- Archeological/cultural site prospecting definition — expanded to include locations of former structures, particularly demolished barracks. With this definition, many installations demonstrated a high need for the land cover data.

What is most interesting from this analysis is that there are high applicability uses that were not on the original list of potential applications in the survey materials sent to the targeted installation personnel.

- The care of forestry resources was clearly identified as an application appropriate at many locations

- The question of fire modeling/management came up often.

- The regular appearance of "Support for Regional Ecosystem Management" reflects installations' awareness of the emerging interest in this area and the suitability of the archival photography to the topic (i.e., the photography covers large areas and was taken before civilian imagery was available).

- The Discovery of Former Training Range Types was a new application for which many installations expressed a real need. The archival imagery is highly appropriate for this application.

Items that surprisingly lacked interest from the installations surveyed were:

- Streamlining NEPA — NEPA is a costly concern, so the expressed lack of interest from the installation staff is surprising.

- Monitoring for Inaccessible Locations — Evidently most installations can access most locations on the base for which they have a concern. Where this need did arise, however, it was clear that the staff thought it a good use. This application may have more relevance to some of the classified imagery and to future sensing, which will be discussed later.

Conclusions — Of the categories of applications possible, vegetation identification and distribution were often the starting points for many other applications. These applications included habitat conservation, fire modeling, forestry, and ecosystem management. High-frequency applications not directly related to vegetation were often associated in identifying past land use patterns such as archeological/cultural site prospecting, discovery of former training ranges, and BRAC support. Surprisingly, NEPA interest was low and water resource monitoring usually was associated with coastline military land management.

Recommendations — Various types of vegetation and land cover questions have the most widespread interest at an installation level and, therefore, should be encouraged. Use of imagery for Streamlining NEPA and Monitoring Inaccessible Locations should be encouraged, particularly in light of the potentially large expense associated with each.

High Interest Applications That Are Relatively Easy To Carry Out

In this case, "easy to carry out" is defined to mean requiring the least amount of equipment and expertise to get the job done. With this in mind, each of the 18 applications was given a rating of 1 (Easy) to 4 (Hard). In most cases, easy meant that simply viewing the image can tell something useful in relationship to what the user needs to know. A more difficult analysis would require scanning the image and comparing it with other images. Applications become harder to do when they require a series of analytical steps that depend on previous steps, or require sophisticated hardware and software modeling routines with operators of a similar level of sophistication. Table 4 lists only those applications with an ease rating of 1 or 2 that were mentioned by more than five installations.

Table 4. Frequently requested and easy-to-carry-out applications.

Application Frequency	Application	Ease
16	Vegetation and Trend Analysis	2
12	Habitat Conservation Management	2
9	Archeological/Cultural Site Prospecting	2
6	Fire Modeling/Prescribed Burns	2
6	Forestry Management	2

Conclusions — There is no widely requested application that is easy to carry out. However, with a little effort, the most commonly requested analyses can be supported nicely by this resource. Also, all widely requested applications can be characterized as a matter of vegetation or land cover change analysis.

Recommendations — The most immediate benefit to the surveyed installations would be to support projects that can be characterized as a matter of vegetation or land cover change analysis. One would infer similar benefits would accrue at other installations not surveyed.

Greatest Value Applications for Cost Savings Potential

The essence of this portion of the research was to identify those applications that, while not necessarily the most popular, will provide the greatest payback to the Army, at least as it pertains to the installations surveyed. To do this, a very broad evaluation was made as to the expressed installation interest in carrying out the application as it was described at their locations. In addition, a similarly broad assignment of the potential cost savings that might result from that application at that installation was rated High, Medium, Low, or None. By this technique, it was hoped that patterns of higher value would emerge. Table 5 shows the results of this evaluation:

- Fire management questions have both good installation interest and high payback even though they are not the most frequently desired applications (per Table 2).

- The question of hazardous material disposal sites is both of great interest to the installations and potentially a cost savings application.

- Questions relating to the operation of the installation mission appear at a higher level here than shown in the Table 2. This finding is important. Basically, a real cost value to the Army's mission exists in the application of this imagery, and installation staff are expressing their recognition of this.

Table 5. Applications with high savings and high interest.

Application Request Frequency	Application Name
4	Fire Modeling/Prescribed Burns
3	Discovery of Unauthorized/Unrecorded Hazardous Disposal Sites
3	Identifying Land Carrying Capacity for Military Usage
2	Forestry Management
2	BRAC Support
2	Determination of Pre-deployment Conditions
2	Discovery of Former Training Range Types
2	Vegetation and Trend Analysis
1	Archeological/Cultural Site Prospecting
1	Cost Effective Monitoring for Inaccessible Locations
1	Erosion
1	Habitat Conservation Management
1	Support for Regional Ecosystem Management

To Table 5 was added the evaluation of how well an application at an installation "fits" the usage of imagery analysis. Table 6 summarizes this evaluation.

Table 6. Applications with high savings, high interest, and good fit to the installation.

Application Request Frequency	Application Name
2	Fire Modeling/Prescribed Burns
2	Discovery of Unauthorized/Unrecorded Hazardous Disposal Sites
2	Identifying Land Carrying Capacity for Military Usage
2	Determination of Pre-deployment conditions
2	Discovery of Former Training Range Types
1	Archeological/Cultural Site Prospecting
1	BRAC Support
1	Forestry Management
1	Support for Regional Ecosystem Management
1	Vegetation and Trend Analysis

What this additional concern shows is that:

- the frequency of occurrence has decreased (i.e., it is harder to find applications that are a really good fit with installation needs), and
- the same applications appear in much the same order as in Table 5.

A similar analysis was run at the "Medium Level of Savings." This secondary savings analysis showed that the basic vegetation identification for temporal

trend analysis is recognized as the "imagery workhorse" application. Interestingly, the related topic of habitat identification came in a strong second. Between them, they represent nearly half of the secondary savings analysis. Historical evaluations (Archeological/Cultural Site Prospecting and Discovery of Unauthorized/Unrecorded Hazardous Material Locations) represent an additional one-fifth in this category. Taken together with Table 5, it is clear that vegetation management and various historical investigations are the bulk of cost-effective applications.

Similarly, if the question of "good fit for application to imagery source" is integrated into the analysis, the distribution that results at the medium level of savings are still land-cover derived information and the exploration of potential historical locations. It appears, therefore, that cost savings are stable and largely independent of how well they fit the particular installation. In other words, it can be inferred that cost savings would be similar across the Army.

"Savings" have probably been emphasized too much here. It is important to keep in mind that many intangible benefits result from this resource's use. For example, the ability to meet a requirement is of high interest, but meeting it may not be associated with savings. In fact, new resources often provide the opportunity to comply with requirements for which no technology previously existed.

Conclusions — Highest payback applications for the installations surveyed are in the areas of forestry management and hazardous materials detection. The next highest cost-benefit rankings are in the applications that deal with land/vegetative cover identification and searches for historical/cultural attributes. Vegetation and land cover identification often are the basis for some other analysis. The test to see how much this varies based on the "goodness of fit of imagery for the application" showed these concerns to be stable in their order.

Recommendations — Those applications that deal with hazardous materials, forestry management, land cover detection, and historical identification are to be encouraged.

Installations With Previous Imagery Exposure

To determine how commonly the installations surveyed had already been exposed to declassified or classified imagery or initiatives, interviewers inquired about their use of civilian imagery, declassified and classified imagery, knowledge or use of NIMA products, or the existence of GATF or Fiducial Sites programs. Table 7 summarizes the responses.

Table 7. Installations with previous exposure to imagery and products.

	Previous civil imagery experience	NIMA products experience	Previous classified imagery experience	GATF or DOD Fiducial Sites experience
Percentage "Yes" of those responding	85% of 20	30% of 17	19% of 21	12% of 17

Conclusions — A large number of installations had had experience with civilian imagery, but very few had experience with any type of classified imagery. As the applications progress to the more classified realm, experience and even knowledge of the existence of the materials decreased dramatically.

Recommendations — Individuals from the land management community need to take a more active role in implementing this resource at installations.

Installations' Access to Facilities That Can Handle Classified Imagery

Interviewers asked how much the installation land manager knows about locally available resources that can handle classified imagery. Table 8 summarizes this knowledge in relation to the available military and local agency facilities and the depth to which these have been explored in the DPW office.

Table 8. Access to facilities that can handle classified imagery.

	Do you have facilities to take advantage of classified imagery?	Could you use G-2* facilities at your installation?	Have you ever worked with the G-2 at your installation?	Interviewee knows G-2 POC	Knowledge of other Government Agencies with secure capabilities
Percentage "Yes" of 23 installations	35%	30%	17%	14%	22%

* G-2 is the Intelligence Unit at an installation.

Conclusions — Some of the installation POCs knew they had facilities available and most of them believed they would be able to use those. It appears, therefore, that access is not really a problem among those who have made the effort to find this information. However, few offices had actually used this type of facility. Finally, experience with classified materials may have come through interaction with other agencies.

Recommendations — Encourage installation personnel to introduce themselves to the offices that can handle secure materials; they are normally supportive. It is a resource that is not being fully exploited by the DPWs at these installations.

Staff Image Interpretation Abilities

Assuming that the targeted installations are interested in the imagery and have access to a secure facility, how sophisticated are they currently in handling the interpretation and increasingly more advanced modeling of the images? Table 9 shows the POCs' comfort in simply looking at an image to extract a piece of information compared with using computer techniques of digital manipulation and data base integration with other spatially referenced installation information.

Table 9. Installation staff image interpretation abilities.

	Naked eye image inspection?	Digital manipulation?	Image processing?	Integration into current GIS dataset?
Installation Positive Responses	83% of 22	83% of 18	71% of 17	88% of 16

Conclusions — Most of the staff responding claimed to be capable of looking at an image and extracting useful information. Of those installations that had some sort of digital manipulation capability, a consistently high percentage had all the most sophisticated spatial analysis and image processing resources they would need. Staff capabilities and hardware resources are not a limitation to the adoption and use of classified imagery. Since staff capabilities and hardware resources are not a limitation to the adoption and use of classified imagery, the question becomes, "Why is its actual usage so low?" (See Table 7.) Results summarized in the **Needs of Installation Staff** section (p 55) show that the installations need only the resource materials (workbook examples and educational materials) in order to take advantage of the resource. Similarly, at those installations where the staff had made the effort to gain access to secure facilities locally (Table 8), they were regularly successful. Therefore, it appears the major obstacle to usage is the access to resource materials (workbook examples and educational materials) and guidance.

Recommendations — Generate and distribute as quickly as possible appropriate resource materials (workbook examples and educational materials) and guidance.

Biggest Problems Experienced in Using/Accessing Imagery

A series of questions was asked to gauge the relative seriousness with which the installation personnel perceived security issues relative to other concerns such as funding, bureaucracy, lack of clearances, lack of facilities (e.g., hardware/software), or availability of a secure site. Table 10 summarizes their comments.

Table 10. Comments for various problems in accessing/using imagery.

Biggest problems dealing with imagery	Could process have been improved?	How were you able to access the data?	Is that the best way?
1. Acquisition 2. Cost efficient data.	----	Not sure	----
Excessive man-hours to find images.	Need to improve USGS website.	----	Yes
Security issues.	----	----	----
Needs immediate access, though not a significant problem.	----	----	----
High definition requires lots of storage space.	----	----	----
1. Getting support and concurrence from upper staffing elements. 2. Disk space for raw data.	Yes	NIMA products requested through Space Command.	1. It works. 2. Funding. Installation is required to pay for all their NIMA products because they are not in a theater situation.
Security Questions: A few mentions			
Funding Questions: A few mentions			

Conclusions — In the minds of the installation staff, funding and security issues were not mentioned often and neither of these questions were considered to be a major impediment to accessing the data. This is a surprise. The installation staff may be a little naive as to the requirements for dealing with classified data, but this data correlates well with the data presented in Table 8, which support the same conclusion. Those outside of the "classified community," therefore, do not perceive lack of a clearance as an insurmountable issue.

Recommendations — Where it is logical to gain a clearance, support the installation personnel in doing so and develop the guidance by which they can achieve this goal.

Installations Receiving Guidance

Installation personnel in this study were asked what guidance they had received from their MACOMs. Note that installations representing U.S. Forces Command (FORSCOM), U.S. Training and Doctrine Command (TRADOC), and U.S. Army Materiel Command (AMC) are included.

Conclusions — No installation interviewed had received MACOM guidance for using or applying declassified or classified imagery.

Recommendations — It is recommended that AEPI, in support and cooperation with DOD, develop a set of guidelines and actions to describe the characteristics, access, and potential application opportunities presented by the imagery under review. It is recommended that the guidelines be implemented through MACOM distribution to installations. This report is offered as a resource.

Needs of Installation Staff To Start Using Imagery

To gain some understanding of the concerns that installation staff felt barred access to and use of the classified and declassified imagery, installation personnel were queried as to their needs for:

- Example applications
- Workshops
- Educational materials
- Funding.

Table 11 summarizes these comments.

Table 11. Needed to start using imagery.

Installation	Examples of application documentation materials	Workshops	Educational forums	Funding to implement a local facility
% Yes	All	60	85	40
% No		20	15	20
% Maybe		20		40

Conclusions — Table 11 presents some interesting results. Most unexpected, all of the survey respondents wanted example materials and procedures to which they could refer. Surprisingly, staffs were highly divided as to whether additional funding was a requirement. It was expected that funding would be the main concern. Although it is important, funding was NOT the most important item on the agenda for installation professionals. It is expected that, once the workbook from Phase II of this project is available, the importance of funding may grow, as managers more clearly understand the opportunities. The survey comments showed a good deal of support for having examples and educational materials available over the Internet. Since this response was volunteered rather than solicited, the fact that it came up is significant. It is the major reason that the "educational forum" option appears as a highly positive response. Individuals viewed workshops variously; either they were useful or they were just a waste of time.

Recommendations — Provide these installations with a catalog of example military applications and some access to this educational information over the Internet.

4 U.S. Air Force, Navy, and Marine Corps Environmental Mission Interest

Background

An effort has been underway for several years within the Federal civilian environmental agencies, such as the Department of the Interior, U.S. Forest Service, and the National Oceanic and Atmospheric Administration, to exploit the national classified high-resolution imaging systems for civil environmental management missions. While the Corps of Engineers is responsible for Army land manager interest, Mitretek Systems has focused primarily on Air Force, Navy, and Marine Corps land managers. The efforts were carried out in separate coordinated studies.

The purpose of the Mitretek project was to begin to apply what has been learned by the Federal civilian agencies to the DOD environmental management community. This chapter discusses the environmental mission interest that Mitretek Systems identified in interviews with personnel at Air Force, Navy, Marine Corps, and a few Army installations. Headquarters personnel were also interviewed.

Approach

Mitretek first identified the military installations to be visited in coordination with the government project manager. They focused on installations in southern California and southwest Arizona because of the concentration of military installations in this region and the importance of these installations for (1) adequate training of U.S. military forces and (2) developing and testing military weapon systems. Other installations were selected that represented other types of environments. Several military headquarters organizations were also selected for visits.

Several military support units were visited in order to gain some insight into the resources available to installation environmental managers to obtain archived imagery and to request new imagery. Mitretek Systems also worked with

several military customer support representatives from the National Imagery and Mapping Agency (NIMA) responsible for helping military personnel use and obtain classified imagery.

Other site visits included several Federal civilian organizations that currently use classified imagery. Civilian land managers for these organizations are responsible for Federal lands surrounding and near the military installations in the Mojave Desert region of southern California. The civilian organization responsible for obtaining classified imagery for civilian agencies was also visited.

Mitretek interviewed personnel responsible for implementing environmental management missions or for obtaining classified imagery. Most personnel were interviewed in person. Table 12 lists organizations visited.

Interviews with military installation or headquarters environmental personnel were conducted in person. Personnel interviewed were usually those responsible for managing natural resources, archeological and cultural resources, and contaminated site cleanup. A few interviewees were responsible for clearing ranges of unexploded ordnance.

Interviews focused on the general environmental management interest in these mission areas and how high-resolution panchromatic imagery could help accomplish the mission. If environmental managers were using remote sensing, ways in which it was being used were discussed, but the focus was on discussing environmental management needs in general rather than remote sensing systems. Most interviews were unclassified because most environmental personnel interviewed did not have security clearances. The few classified interviews were conducted at the secret level of security. The purpose of the interviews was to identify the types of environmental management needs and to find out how managers thought high-resolution imagery could provide data not now available or could add value to the management activities already in place.

Military support unit personnel were interviewed to determine what on-installation or other resources are available for accessing classified imagery systems and how installation environmental managers can become customers for classified imagery through the normal chain of command.

Table 12. Additional military service organizations interviewed.

Military Environmental Management Organizations
Navy
Naval Air Weapons Station, Ridgecrest, CA
Naval Facilities Engineering Command, Southwest Division, San Diego, CA
Naval Facilities Engineering Command, Atlantic Division, Norfolk, VA
Naval Facilities Engineering Command Headquarters, Alexandria, VA
Patuxent River Naval Air Station, Lexington Park, MD
Naval Meteorological and Oceanography Command, Stennis Space Center, MS
Naval Oceanographic Office, Stennis Space Center, MS
Chief of Naval Operations Environmental, Safety, and Occupational Health Division, Arlington, VA
Marine Corps
USMC Camp Pendleton, Oceanside, CA
Air Ground Combat Center, Twentynine Palms, CA
USMC Air Station, Yuma, AZ
USMC Camp Lejeune, Jacksonville, NC
USMC Air Station, Cherry Point, NC
Commandant of the Marine Corps, Environmental Management Program, Arlington, VA
Air Force
Edwards Air Force Base, Rosemond, CA
Nellis Air Force Base, Las Vegas, NV
Luke Air Force Base, Phoenix, AZ
Air Combat Command, Newport News, VA
Air Force Center for Environmental Excellence, San Antonio, TX
Army
National Training Center, Fort Irwin, CA
Fort Eustis/Fort Story, Newport News, VA
Training and Doctrine Command, Newport News, VA
Army Environmental Center, Edgewood, MD
Military Support Organizations
2nd Force Imagery Interpretation Unit, USMC Air Station, Cherry Point, NC
2nd Topographic Platoon, USMC Camp Lejeune, Jacksonville, NC
Marine Corps Intelligence Activity, Suitland, MD
US Marine Corps, Imagery Plans and Policy Office, Arlington, VA
Federal Civilian Organizations
Mojave Desert Ecosystem Program, Barstow, CA
Mojave National Preserve, National Park Service, Barstow, CA
Bureau of Land Management Field Office, Barstow, CA
Bureau of Land Management Field Office, Needles, CA
Joshua Tree National Park, Twentynine Palms, CA
Civil Applications Committee, Reston, VA
USGS Advanced Systems Center, Reston, VA

Federal civilian land managers in southern California were interviewed to identify how these managers are affected by activities on the regional military installations, to determine what issues were of common interest, and to find out to what extent these civilian agencies were using classified imaging systems. Members of the Civil Applications Committee and the USGS Advanced Systems Center were interviewed to determine policy or other issues associated with military organizations using the Advanced Systems Center to obtain classified imagery.

Applications Identified in Personnel Interviews

Table 13 lists the applications identified in the interviews conducted for this study. The results are presented for military installation environmental managers, military support unit personnel, and civilian organization environmental managers.

Table 13. U.S. Navy, Air Force, and Marine Corps summary environmental applications identified for high-resolution classified imagery.

Environmental Mission Area	Application
Sustainable Training Land Use	Supporting sustainable training land management programs Determining before- and after-exercise land condition Managing erosion Managing bombing target cratering
Environmental Compliance	Cleaning up contaminated sites Implementing the Range Rule Maintaining and recovering threatened and endangered species
Natural Resources Management	Mapping, monitoring, and detecting change in vegetation Identifying habitat and monitoring habitat condition Monitoring permanent land plots and transects Controlling invasive non-native vegetation species Managing forestry programs Managing fire Managing and controlling large animals Monitoring and managing inaccessible and limited-access areas Assessing storm damage Determining shoreline change Locating abandoned mines Determining land elevation
Cultural Resources Management	Surveying areas to direct ground investigations Locating new sites or features Monitoring known sites

Military Installation Environmental Managers

Analysis of data from personnel interviews with military installation environmental managers found that there were potential applications of high-resolution imagery in military operations support, environmental compliance, and environmental and cultural resources stewardship mission areas. Table 13 lists these categories and the potential applications identified within each category. These categories and applications are discussed in more detail in the following sections. Many of the identified applications were the same as or similar to those identified by the Corps of Engineers' survey of Army installation managers and discussed in Chapter 2 of this report.

Sustainable training land use.

Installations visited during this project have extensive training missions to maintain operational readiness of military forces. Training activities must take place on a sustainable basis, which means that training lands must be managed and training exercises conducted in a way that does not degrade the capability to use the lands to train future generations of soldiers. This challenge requires extensive management and monitoring of natural resource conditions, and resource management programs have been developed for this purpose. Installation managers stated that high-resolution imagery could be an additional resource that provides additional and better data needed to manage training lands in a sustainable way.

Supporting training land management programs. Programs to help manage training lands for sustainability of training activities have been developed. Examples cited by environmental managers are the Integrated Training Area Management (ITAM) Program and the Land Condition Trend Analysis (LCTA) Program. The programs require data on a number of ecological and physical characteristics of the environment as input to management activities. Some of the data needs are the same as or similar to those discussed in the section on natural resources management (page 63). Installation managers stated that high-resolution imagery could be new sources of data and information for these programs or could replace current methods of obtaining data.

Determining before- and after-exercise land condition. Installation managers stated that they must determine the effects of each training exercise on training lands so that restoration measures can be implemented as needed as part of training land management activities. Currently, this determination must be made by on-the-ground inspection after each exercise. Managers at the USMC Air Ground Combat Center and Fort Irwin, CA, stated that this was often difficult because of the size of these installations and the difficulty of getting around on the installation without good roads. They stated that high-resolution imagery of specific training areas of interest before and after a training exercise could make this task much easier or might be able to reduce or eliminate the need to conduct an after-exercise on-the-ground survey. Imagery availability would have to be timely for it to be useful for this purpose. They stated that obtaining the imagery as part of the exercise could help assure timeliness of delivery of the imagery.

Managing erosion. Activities such as repeated bivouacking at the same locations and heavy use of tracked and wheeled vehicles can stress training lands and cause erosion. Erosion must be controlled or avoided to keep training lands

useable and to avoid unacceptable sedimentation of streams and other water bodies. If excessive and extensive erosion occurs, training land must be taken out of use, often for a long time, until the erosion can be remedied and the land recovers and can be used once again for training. Managers stated that areas of erosion must be identified and areas known to be subject to erosion, such as stream crossings, must be monitored so that appropriate remedial actions can be taken as needed. They also stated that high-resolution imagery could be useful for monitoring erosion areas as an addition to on-the-ground inspection.

Managing bombing target cratering. Bombing target areas become cratered, and managers stated that this condition must be monitored and remedied as required. On-the-ground access to the target areas is often difficult or not possible because of the hazard of unexploded ordnance. Managers stated that high-resolution imagery could be a good way to monitor these target areas regularly and plan remediation activities effectively and efficiently.

Environmental compliance.

Military installation environmental managers are responsible for assuring compliance with environmental laws and regulations. Environmental managers often mentioned three compliance programs as having the most potential for using high-resolution imagery. These programs are cleaning up contaminated sites, implementing the Range Rule, and managing threatened and endangered species.

Cleaning up contaminated sites. Installations must find and remediate sites contaminated with hazardous materials. In general, managers who were responsible for cleanup stated that the programs at their installations were mostly in the final site remediation phase. These managers did not identify much need for high-resolution imagery during that stage of the programs.

A few managers, however, were still trying to locate old contaminated sites. In these cases, archived imagery was considered a possibly valuable resource that could provide a historical record showing activity sites, locations of old buildings that contained activities that could have contaminated adjacent areas, or the location of old landfills.

Implementing the Range Rule. DOD must remediate old bombing and gunnery ranges under the requirements of the Range Rule promulgated by the U.S. Environmental Protection Agency. An important remediation issue is finding and removing unexploded ordnance. Often, however, the locations of old ranges

are no longer known. These ranges may be on active military installations or on land no longer under the control of DOD.

Managers stated that both archived and new imagery could be valuable for finding old ranges. Archived imagery could possibly show ranges when they were still active. Managers also stated that it is likely that land surface features could be visible at high resolution in archived or new imagery that could indicate target locations. These locations could then be investigated on the ground. Managers also stated that, if old firing locations could be found, then the firing fans could be estimated and investigated on the ground.

Maintaining and recovering threatened and endangered species. Federally listed TES that are present on military installations must be identified and protected under the provisions of the Endangered Species Act. Populations that exist must be maintained and recovery plans must be prepared and implemented for them. All managers interviewed stated that this issue is important on their installations and has a moderate to large potential to affect training activities adversely. High-resolution imagery was felt to be useful to help identify appropriate habitat and to monitor habitat recovery and condition.

Natural resources management.

All military environmental managers have an environmental stewardship mission as owners and users of public lands. This mission area requires documenting installation natural and physical resources and maintaining the health of these resources for future generations. Managers interviewed saw a number of activities in this mission area that could potentially benefit from using archived and new high-resolution imagery.

Mapping, monitoring, and detecting change in vegetation. The need to be able to identify and map vegetation types was expressed as a high interest at a number of installations as part of activities to document and delineate the types of natural communities that occur. These data are important inputs to TES management described earlier. Vegetation communities must also be monitored for changes due to training activities or natural environmental variations, and maps must be updated as needed. Commercial satellite data in the past has not had sufficient resolution to meet this requirement. Installations have used aerial photography to provide sufficient resolution, but this resource is not often available because of its high cost. Managers stated that new high-resolution imagery could be a valuable supplement to periodic aerial photography, allowing more frequent monitoring of sections of installations of particular interest. Archived

imagery could be valuable for a historical record that is not available from other sources.

Identifying habitat and monitoring habitat condition. Identifying types of habitats and monitoring habitat condition over time were identified as important concerns. These concerns are similar to and require similar data as the vegetation identification, mapping, and monitoring activities discussed in the previous paragraph. Habitat identification was stated to be particularly important for managing TES. High-resolution images are needed to meet these applications. Managers stated that both archived and new imagery could be useful.

Monitoring permanent land plots and transects. Some installations maintain permanent plots or transects of land that are surveyed in various ways on a regular schedule (usually annually or every few years) as a way to create a record of change over time due to activities on the installation, natural environmental variation, or other factors. The locations of these plots are often kept confidential so that installation users do not treat these areas differently when carrying out their training or other types of activities. Environmental managers have been using various means to monitor these areas, such as personal visits, hand-held ground-level photography, or statistical scientific sampling. Managers stated that high-resolution imagery could be a valuable addition to or replacement of current ways of monitoring these plots and transects. Archived imagery could be another source of data on the historical condition of these areas not available elsewhere.

Controlling invasive non-native vegetation species. Installation managers in the southwest stated that tamarisk, an invasive non-native species of shrub, is a major threat to riparian habitats. This shrub will replace native species, resulting in large changes to riparian habitats. As a result, tamarisk must be monitored and controlled. Other invasive species, such as cheatgrass, could also become problems in the future. The spread of tamarisk is currently monitored from the ground, which is sometimes a problem because of limited access to installation lands and the inaccessibility of some of the areas to be monitored. High-resolution imagery was felt to have high potential to improve monitoring of invasive species.

Managing installation forestry programs. Installations with woodlands often have forestry programs to produce wood for sale. Such programs were described at USMC Camp Lejeune and USMC Air Station Cherry Point, NC. The Air Force Center for Environmental Excellence stated that such programs also exist at many Air Force installations. Managed in ways similar to U.S. Forest Service and private sector programs, field data and observations are important parts of

these forestry management programs. The resolution of commercial satellite imagery was insufficient to be useful for these programs, but managers stated that classified high-resolution imagery could be a valuable supplement to current ground-based field activities.

Managing fire. Managing fires on installation lands was mentioned by a number of installations as an important activity. Deliberately set fires (prescribed burns) are used as an important natural environment management tool for installations with ecosystems adapted to fire as part of the natural system. Wildfires started either by live munitions used on gunnery and bombing ranges or by lightning on all installation land must also be controlled and managed. Managers stated that classified imagery could be very useful for wildfire management on impact areas because of the difficulty of accessing these areas. Needs expressed were to document the area burned by wildfires and to monitor fuel build-up for fire management purposes. Managers also felt that high-resolution imagery could be a valuable addition to managing prescribed burns to determine the area burned, to analyze the results of the burning, and to monitor the build-up of fuel in ecosystems subject to fires as input to scheduling prescribed burning activities.

Managing and controlling large animals. Managing populations of large animals was identified as an issue at installations in the southwest. Wild horse and burro populations were identified as a particular problem. Bighorn sheep and the Sonoran pronghorn antelope (an endangered species) were also mentioned as management issues. High-resolution imagery was felt to have potential to help determine population sizes and identify areas used by these animals. These data are important for developing population management strategies. Because these animals move freely among DOD and adjacent lands, installation managers stated that this issue could benefit from cooperative use of classified imagery to support joint control and management programs.

Monitoring and managing inaccessible and limited-access areas. Some installation managers stated that environmental management activities are hindered because of the inaccessibility of some installation areas or the access limits placed on environmental managers. Examples of inaccessibility are range impact areas and some areas of rugged terrain. The large size of installations and the lack of good roads, such as at the USMC Air Ground Combat Center (Twentynine Palms, CA) and Fort Irwin, CA, also contribute to accessibility problems. Environmental managers at these two installations also have many limits on access to the installation lands because of safety issues and interference with force training exercises. Managers expressed interest in high-resolution imagery that could provide a substitute for or an addition to on-the-ground activities. They

felt that such a use could help overcome installation access problems and enhance environmental management activities.

Assessing storm damage. The ability to assess storm damage to installation lands from hurricanes was stated to be a need at USMC Camp Lejeune and USMC Air Station Cherry Point. A capability for quick access to high-resolution imagery could be an important supplement to on-the-ground surveys.

Determining shoreline change. Several installations with marine shorelines, such as Fort Story, VA, and USMC Camp Lejeune, identified a need to determine old shoreline positions and to track shoreline changes in the future. These managers stated that archived imagery could be very valuable for obtaining historical positions of shorelines and that new imagery could be used to track the future changes.

Locating abandoned mines. Southwestern installations expressed some need to locate old abandoned mines so that it can be determined if they are a safety hazard. The resolution of commercial satellite imagery is not adequate for this task. Funding and staff time is limited for accomplishing this activity on the ground. Managers felt that the resolution of the classified imagery would make it useful for mine location. Archived imagery could be useful if available, or new imagery could be obtained for areas suspected of having abandoned mines or with a high potential for mines. Using high-resolution imagery could reduce the time and effort needed to accomplish this activity and help direct activities that must be conducted on the ground.

Determining land elevation. Several installations stated that land elevation data are required as part of managing installation water resources and identifying flooding areas that could affect military training activities. Managers expressed interest in digital elevation models if the scales required could be produced from the national systems data.

Cultural Resources Management.

All military environmental managers must act as stewards for the public owners of cultural resources on DOD lands. Cultural resources include archeological resources and buildings, facilities, and features determined to be historically significant. Implementing this mission requires that installation managers survey installation lands and investigate and preserve cultural resources that are present. Managers interviewed felt that high-resolution imagery could contribute to this mission.

Surveying areas to direct ground investigations. Some installations visited have not been entirely surveyed to determine areas with potential for archeological sites and resources. These surveys are conducted only when funding is available. Persons with expertise (often contractors) carry out the surveys, and a variety of observed environmental factors are used to determine which areas require more detailed ground investigation. If available, aerial photography is often used to look for land features that show or suggest the presence of archeological resources or which are indicators of the likely use of the area by people throughout time. Installation managers stated that the availability of high-resolution imagery could help them complete these surveys. It was felt that archived data could probably provide much of the imagery needed. New imagery could be used to survey areas not covered by archived imagery and for areas suspected to contain or with high potential for archeological resources. Information from analysis of the imagery would be used to determine where and how best to deploy ground-based investigations.

Locating new sites or features. Installation managers stated that land surface features often show the presence of archeological or historic resources. These surface features are often very difficult to discern during ground-level surveys; however, they can be seen in aerial photographs, if available. Examples cited were fire pits and trails used by pre-Columbian native Americans. The resolution of commercial satellite imagery is not adequate for this purpose. Managers stated that archived and new high-resolution imagery could be a very valuable source of aerial images to be analyzed for such land surface features.

Monitoring known sites. Installation managers must preserve known archeological and historic resource sites and protect them against degradation, theft, and vandalism. This activity is sometime difficult to accomplish because of access limitations to installation lands and the lack of time and personnel to inspect the sites at frequent enough intervals. Managers stated that the ability to obtain high-resolution images periodically could be useful in increasing their ability to monitor the condition of these sites and to determine if vandalism or theft ("pot hunting") is occurring.

Military Support Organizations

Personnel at several USMC military organizations were interviewed (Table 12) as examples of the normal military chains of command for requesting and obtaining classified imagery. The interviews focused on determining the resources available to USMC environmental managers for accessing the classified imaging systems, determining how the normal USMC chain of command for imagery

requests might work, and finding out the receptiveness of these organizations to environmental managers as customers for classified imagery.

The topographical platoon and imagery analysis units were both receptive to the idea of environmental managers becoming customers for classified imagery. These units also believed that they were well equipped to support environmental imagery requests and could understand the needs for tasking imagery for environmental purposes. The USMC Imagery Plans and Policy Office supported the idea of USMC environmental managers using classified imagery for environmental mission purposes and foresaw no impediments in current USMC policy that would need to be changed to meet such applications.

Civilian Organization Environmental Managers

Civilian organization environmental managers (Table 12) interviewed in the Mojave Desert region generally stated environmental management needs are similar to those of the regional military installation environmental managers. The civilian managers also stated that they are affected by some military activities, such as aircraft overflights. In general, the civilian managers felt that they could benefit from cooperation with their military neighbors on environmental issues.

Some civilian managers were already using classified imagery to meet some environmental management requirements. Civilian managers also seemed to have better knowledge than military installation environmental managers of the existence of the classified systems and the ability to use them to support mission needs.

Other General Findings

This section reports on some other general findings from the interviews. These issues include classified imagery applications to environmental mission support, personnel knowledge of the classified imaging systems, ability of military environmental personnel to handle classified information, interest in using classified imagery for the environmental mission, and support available to obtain classified imagery.

Classified imagery applications to the environmental mission.

Analysis of the environmental needs specified in the interviews indicates that many of these needs could be met or substantially enhanced with classified imagery. Some of the needs were the same as or similar to those of civil

environmental agencies, which are already using classified imagery to satisfy these needs.

The high resolution of the imagery was felt to be a very useful property. Commercial satellite imagery, such as LandSat or SPOT, is not being used because the resolution is not good enough for many of the needs specified in the interviews. Classified imagery could be used to supplement or replace aerial photography for many applications.

Personnel knowledge of the classified imaging systems.

Almost all environmental managers interviewed were unaware of the existence of the classified imaging systems or that they could use this asset to support their environmental mission. One Air Force organization had learned of the classified systems and had instituted a project with the help of the NIMA customer service representative for that command. A Navy organization had tried to use the classified systems several years ago, but had given up on the attempt because the organization helping them made it appear to be too hard to use the asset. Because installation environmental managers were mostly unaware of the classified systems, they were also not aware of the chain of command or military units that could support them with requests for classified imagery.

Ability to handle classified material.

Many of the environmental managers visited had no security clearances. Those staff that did have secret clearances usually had them because of other activities that the office was involved in. For example, many staff members at Edwards Air Force Base, CA, had secret clearances because the test and evaluation mission of the base involved many classified activities that needed environmental oversight. The personnel in the Geographic Information System office at the USMC Air Ground Combat Center had secret clearances because the group also worked with tactical military organizations on the installations.

Because most environmental managers had no security clearances, their offices were generally not set up or approved to receive, work with, or hold classified material, such as classified satellite imagery. Most managers did not view this as a problem, however, because they believed that there were facilities on their installation that could be used when needed or that they could use contractors that had appropriate facilities for handling the classified imagery and other material. The existence of adequate secure facilities that could be made available was confirmed for two of the USMC installations visited.

Most managers stated that, if they were to use classified imagery routinely, it was likely that they would need to hire contractors to do much of the analysis. A requirement for adequate facilities to handle the classified material at the appropriate security level would be part of the procurement.

Interest in using classified imagery for the environmental mission.

Interest in using classified imagery for environmental management purposes was variable, but generally positive. Most managers could think of good uses for the data and felt that it could enhance their current efforts and activities and allow them to do some things that they were now unable to do. However, some managers felt that using classified systems and information was too much trouble. Since most managers did not have a security clearance, they did not know how they could proceed to learn more about the systems.

The lack of any exposure to the imagery was a major deterrent to many managers to understanding how classified imagery could help their programs. Many stated that they would need to see the imagery before they could be certain of its usefulness to them — a finding also identified by the Army (see Chapter 2).

Need for Unclassified Information

Most environmental managers stated that much of the information needed had to be unclassified because they often dealt with other Federal and state agencies and the public. The managers stated that imagery-derived products could probably be used and would probably be adequate for interacting with these organizations and groups.

Support Available To Obtain Imagery

Interviews with USMC military units responsible for obtaining and working with classified imagery indicated that resources are available on those installations to help environmental managers use this imagery. Personnel interviewed at the Navy Meteorological and Oceanography Command stated that the command was the proper Navy organization to provide imagery services to Navy environmental managers and could do so through the regional offices. Support organizations in the Air Force were not identified during this phase of the study.

U.S. Navy, Air Force, and Marine Corps Summary

- Military installation environmental mission applications were identified that could benefit from the availability of high-resolution imagery.

- Many installation environmental needs are the same as or similar to civil environmental organization needs, and these organizations are already using classified imagery to support these needs.

- Installation environmental managers and headquarters personnel are interested in how they could use classified imagery to support environmental management missions.

- Installation environmental managers were mostly unaware of the existence or capabilities of classified imaging systems and stated a need to see examples to determine its usefulness for their mission.

- No service component policy barriers were identified that could prevent environmental managers from becoming customers for classified imagery through normal chain of command procedures.

- Adequate installation support from military organizations appears to be available to assist military environmental managers with obtaining and using classified imagery.

- Demonstration projects are needed to expose military environmental managers to classified imagery and to exercise the military systems available for obtaining imagery for environmental customers.

5 Conclusions and Recommendations

Conclusions

The United States has a long history of imaging the surface of the earth from space. Images that were highly classified are becoming available to support land management activities. Basically three types of imagery are available:

- Archival images from the 1950s to early 1970s, which are now declassified and can be easily acquired
- Archival images from the early 1970s to the present, which still remain classified (at a secret level or higher)
- Instruments that can be tasked to acquire images in the future, which are and will remain classified at a secret level or higher.

Considering just the declassified archival images it can be stated:

- Satellites were regularly imaging much of the United States almost from the beginning of their missions (as early as 1959).
- Black and white photographic products of very high resolution (9 feet or about 3 meters), taken beginning in the mid-1960s for most U.S. installations can be expected to be available.
- Acquisition cost is minimal and photographic material can be easily processed into digital form.
- Enough data exist that the statement can be made confidently that some images will exist for most installations.
- This is a unique archive that was not previously available.

If military applications can be identified for the declassified images, then classified images can also be expected to be of great interest to installation land managers in carrying out their installation operations and management tasks.

However, the "civilian" portion of the military land managers within the installation DPW offices to a large extent have not taken advantage of this resource.

The questions that this summary addresses are:

- Are installation DPW staff elements interested?
- What is their current situation?
- Which applications will provide the highest payback to the military?
- What is required to support the integration of this material into DPW missions in the most cost-effective manner?

To answer these questions, representative installation land manager offices were surveyed for Army, Navy, Air Force, and Marine Corps. Installations represented those that institutional knowledge suggested would most benefit from using satellite imagery. Chapter 2 contains a verbal summary of the Army interviews followed in Chapter 3 with comparative statistical analyses with recommendations for specific findings. Chapter 4 presents the findings for the Air Force, Navy, and Marine Corps, done independently but at the same time.

Service-wide, a large majority of the installations responding were very interested in the potential usage of the imagery. Considering the quality of the illustrative materials available for the survey, this level of interest probably represents a minimum. Most respondents recognized that the imagery would be able to fulfill more than one of their needs. Installations with more sophistication in staff and equipment tended to be more enthusiastic and have a greater interest in the data.

Some installations have successfully used the imagery. Many expressed the interest in "getting their feet wet" by using archival imagery for historical purposes, often by simply looking at the image (Figure 26). Their view is to go slowly with the least initial effort and put more resources toward it once it has proven its value for simple initial applications.

The applications identified as most commonly needed were by far the identification of vegetation (i.e., land cover, since that is what imagery deals with) and the changes in land cover that take place over time. Many of the other applications use land cover (Figure 27) as applied to other important questions such as habitat conservation, fire modeling, forestry, and ecosystem management. Desired applications that do not directly relate to vegetation were often associated in

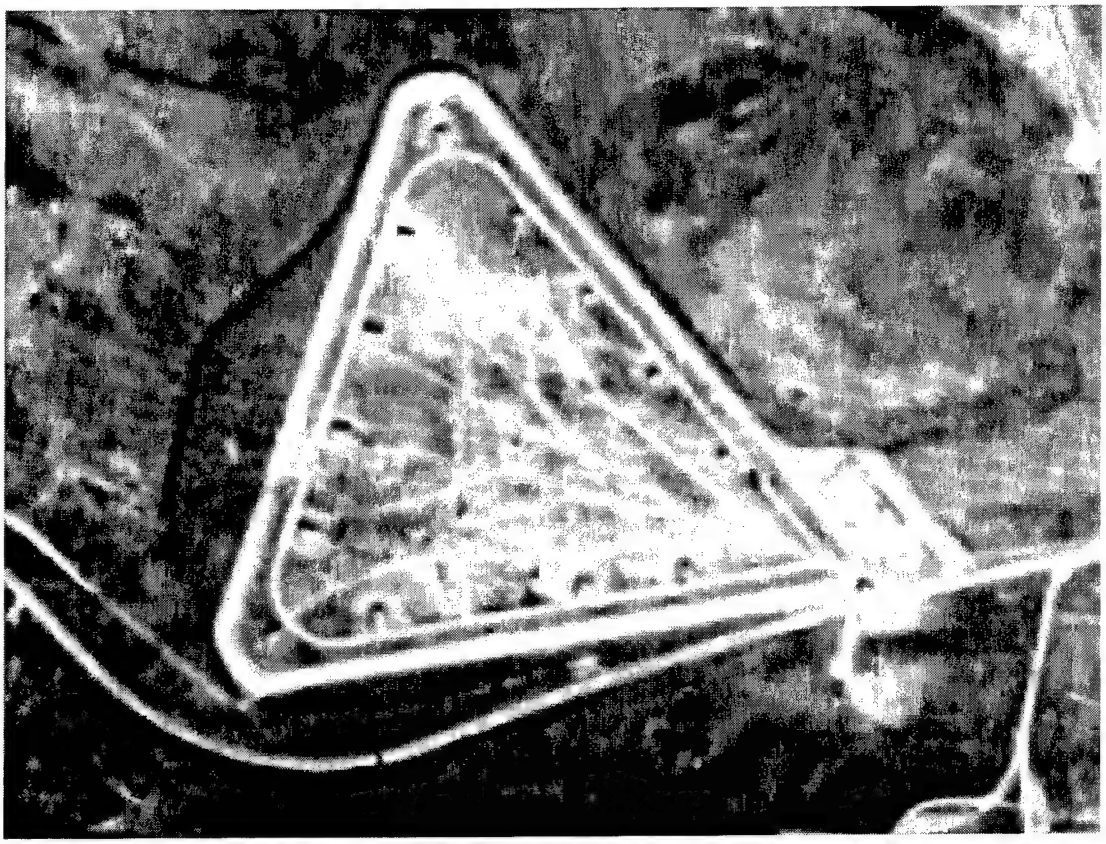

Figure 26. Using just the naked eye to look at an image may be sufficient to identify distinctive land uses such as in this 1965 photograph at Fort Carson, CO.

identifying past land use patterns such as archeological/cultural site prospecting, discovery of former training ranges, and BRAC support. An additional analysis was done to determine which applications were relatively easy to carry out (simply by looking at an image to get an answer to a question). Fortunately, the frequently requested and easy-to-carry-out applications are basically the same as those that are of highest interest at the installations.

A most significant question is, "Which are the greatest value applications for cost savings potential?" This question was examined from two directions, those that showed a high level of savings with a high level of installation interest and a similar analysis that integrated how well the application fit the imagery's character. In either case, those applications that resulted were much the same (i.e., the most desirable applications are not highly sensitive to change). Fortunately, the frequently requested and easy-to-carry-out applications are those that also show a good cost savings potential and good fit. The best payback applications are in the areas of forestry management and hazardous materials detection. The next highest cost benefits are in applications that deal with land/vegetative cover identification and searches for historical/cultural attributes.

Figure 27. This 1963 image at Fort Story illustrates how historical vegetative edges, roads, shorelines, and barracks and other buildings can be delineated.

It is also important to keep in mind that many intangible benefits result from this resource's use. For example, the ability to meet a requirement is of high interest, but meeting it may not be associated with a saving. In fact, we often need to realize that new resources provide the opportunity to comply with requirements for which no adequate technology previously existed.

How commonly have installations already been exposed to declassified imagery or initiatives? A very large number of installations surveyed had experience with civilian imagery, but very few had experience in dealing with any type of classified imagery. As the applications progressed toward the classified realm, experience and even knowledge of the existence of these materials decreased dramatically. It is recommended that individuals from the land management community take a more active role in implementing this resource at installations.

Can installations access facilities that can handle classified imagery? Many of the installation POCs knew they had facilities available, and most of them believed they would be able to use those facilities. Access, therefore, is not perceived as a problem among those who have made the effort to find out. However, those offices that have actually used secure facilities are rare; sometimes it occurs via interaction with other agencies.

Do the staff at installations have the ability to interpret the imagery, and how sophisticated are they? Most respondents claimed a basic expertise. However, it is highly significant that a consistently high percentage of installations (in the 80 percent range for Army installations) that claimed a digital manipulation capability, also had all the most sophisticated spatial analysis and image processing resources they need (Figure 28). Staff capabilities and hardware resources, therefore, are not a limitation to the adoption and use of classified imagery.

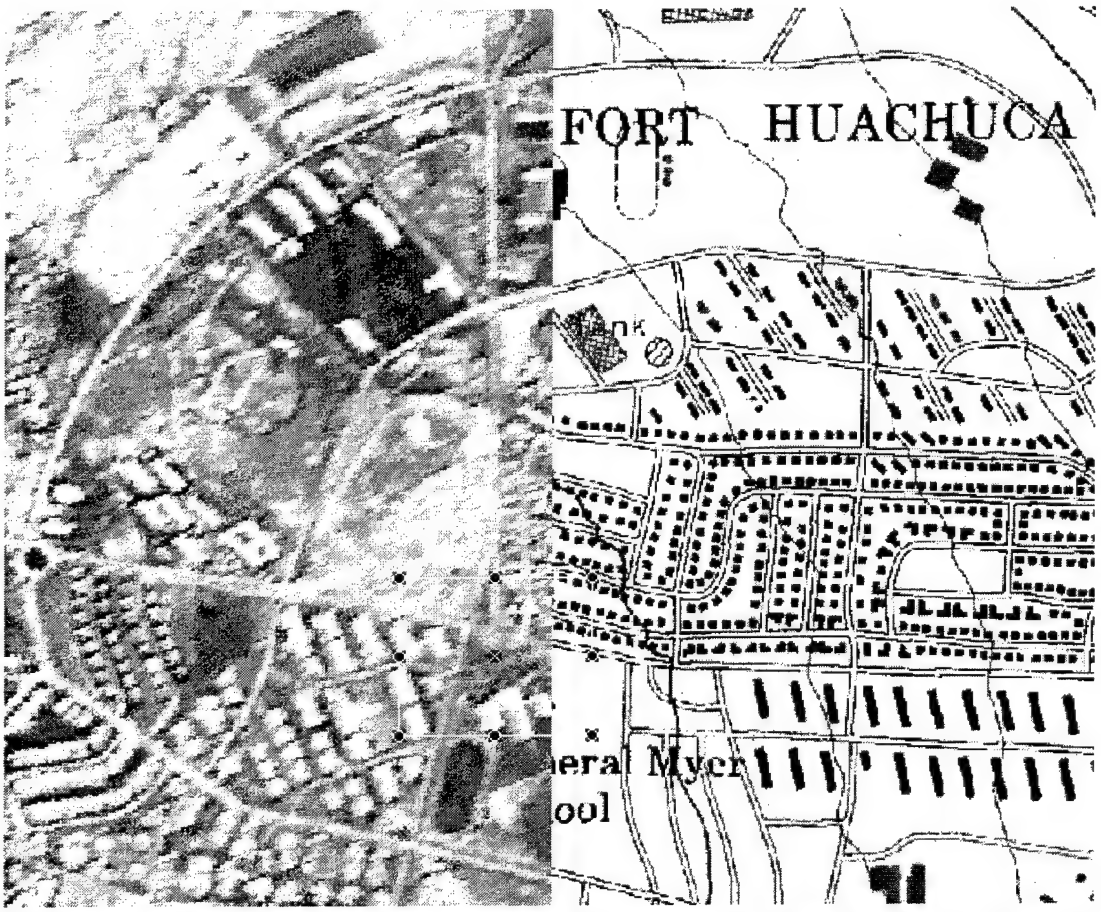

Figure 28. Most installations have the equipment to integrate the imagery into a geo-referenced GIS. 1965 image geo-referenced to a USGS digital raster graphic (DRG) 1:24,000 scale topographic map.

Since staff capabilities and hardware resources are not a limitation to the adoption and use of classified imagery, the question becomes, "Why is its actual usage so low?" Interestingly, the staff claimed neither funding nor gaining a clearance as being of primary concern. When asked,

- "What do you need to start using this imagery?" "Examples" was the reply given by all of the Army respondents. Nearly as high a percentage requested educational materials. Interest in an Internet web site was brought up voluntarily by some installation staff. The installations need only workbook examples and educational materials to take initial advantage of the resource. Other military services expressed similar interests.

- "Are you following your MACOM's guidance?" No Army installation responded that it had received guidance. It is suspected that, similar to the installations, the MACOMs have not been informed as to characteristics, access, and potential applications of the imagery. It is hoped that this report will begin to provide this information.

All things considered, the installations surveyed were in a relatively good position to begin the application of declassified and classified imagery for land management. The staff is capable, interested, and has at its disposal the technical resources to do sophisticated analyses if so desired. Some installations have successfully applied the imagery. The most commonly requested potential applications are also those that can be the easiest to carry out and provide the greatest cost savings. Access to secure resources on the installation and need for clearances are not perceived as overwhelming obstacles. Funding is not perceived as a major issue at this time.

Recommendations

- Workbook examples and educational materials should be developed.

- Coordinated service-wide workshops would be useful.

- DoD and service guidance is desirable.

- Provide list of points of contact, existing introductory materials (documents, videos, internet locations).

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Glossary

A-E firm	Architectural and Engineering firm
AEPI	Army Environmental Policy Institute
AMC	Army Materiel Command (the Army MACOM that tests and manufactures material)
BRAC	Base Realignment and Closure
CAC	Civil Applications Committee
CERL	Construction Engineering Research Laboratory (an ERDC campus)
CIB	Controlled Image Base
DEM	Digital Elevation Model
DMSV	Digital Multispectral Video
DOD	Department of Defense
DPW	Directorate of Public Works
ERDC	U.S. Army Engineer Research and Development Center (The Corps of Engineers' Research Laboratories)
Fiducial Sites Program	— A government program to regularly take images of different locations (sites) using NTM resources for civil purposes.
FORSCOM	U.S. Army Forces Command (the standing Army – a MACOM)
FUDS	Formerly Used Defense Site
GATF	Government Applications Task Force

GIS	Geographical Information System – A computer software package that allows manipulation of mapped and imagery data.
GLIS	Global Land Information System (an Internet website run by the USGS)
ITAM	Integrated Training Area Management
LandSat	U.S. multi-band imaging satellite. Includes MSS and TM sensors
LCTA	Land Condition Trend Analysis (a program within ITAM)
LOTS	Logistics Over the Shore
MACOM	Major Army Command
Mitretek	Mitretek Systems (a research company; a partner author of this report)
MSS	Multi-Spectral Scanner (early LandSat U.S. 4-band imaging satellite)
NEPA	National Environmental Policy Act of 1969. This act outlines how Federal actions are to be documented as to their environmental ramifications.
NIMA	National Imagery and Mapping Agency (formerly Defense Mapping Agency)
NPL	National Priorities List
NTM	National Technical Means (a name for those technologies that include classified imagery)
ODUSD(ES)	Office of Deputy Under Secretary of Defense for Environmental Security
POC	Point of Contact
RCW	Red-Cockaded Woodpecker (an endangered species in the Southeast)

SWHU	Solid Waste Hazardous Units
SPOT	Systeme Probatoire pour l'Observation de la Terre (France's earth observation satellite)
TEC	Topographic Engineering Center (an ERDC campus)
TES	Threatened and Endangered Species
TM	Thematic Mapper (U.S. 7-band imaging satellite)
TRADOC	U.S. Army Training and Doctrine Command (the Army MACOM responsible for training)
TTC	Tropical Test Center (formerly located in the Panama Canal Zone)
USGS	United States Geological Survey, U.S. Department of the Interior
USMC	United States Marine Corps

Appendix A: Initial Installation "Cold Call" Script

- Hello I am_____.
- I am involved with a DOD-level project to determine potential applications of (formerly) classified remotely sensed photography and imagery.
- This comes through the Office of the Deputy Under Secretary of Defense for Environmental Security (DUSD-ES) through their Legacy program.
- The purpose is to let you installation folks know what is available for application to installation land management questions.
- We'd like to send you some brief reference material to examine and
- Follow up with a phone conversation about potential uses or successes (or limitations) you may have had.
- We would like to discuss this with the appropriate environmental and natural resources person at your location.
- Would you be an appropriate POC on your post (or installation) to handle that?
- Can I verify this address and phone number?
- Would there be other POCs?

Appendix B: Initial Installation Mailing

The following information was sent overnight by express mail or sometimes by e-mail. It was sent as soon as possible following the initial contact made with the script in Appendix A.

Background Material for (De)Classified Imagery
Applications to Military Test and Training Lands

Breadth of Usage

We have found several potential applications of (De)Classified Imagery for Military Test and Training Lands at various installations. The degree of sophistication varies considerably and uses range from creating a simple visual record to image processing and analysis to combining them with installation GIS data to carry out further manipulations.

Example Applications

Some example applications would include:

- Conditions directly before and after military maneuvers (change detection)
- Cost effective monitoring for inaccessible locations
- Streamlining NEPA by supporting adaptive monitoring and mitigation
- Discovery of unauthorized/unrecorded hazardous disposal sites
- Archeological/cultural site prospecting
- Extending management and climate change trend analysis baselines
- Support for regional ecosystem management

- Determination of pre-deployment conditions
- Identifying land carrying capacity for military usage
- Habitat conservation management
- Habitat identification and change
- Pre-deployment HAZMAT IRP clean up
- The identification and documentation of POL spills.

Characteristics of Unclassified Data of Interest

- Satellites were regularly imaging much of the United States almost from the beginning of their missions (as early as 1959)
- Black and white photographic products of very high resolution for most U.S. installations (beginning in the mid-1960s) can be expected to be available (see Figure B1)
- The resolution of these early photographic products is up to 9 feet (~3 meters) on the ground
- Enough data exists that some images will exist for most installations within the United States
- For many installations that do not have an alternative source of historical imagery, this is a unique archive that was not previously available
- Archives exist from the late 1950s to 1972.

Characteristics of Classified Data

- This material exists after 1972.
- Handling it would require a secure facility.
- There is movement to decrease the classification level on this newer material. Given enough response, your input can help make this happen.

Since characteristics of this material cannot be discussed here, please discuss the types of activities you would like to see happening with remotely sensed imagery. For those items where CERL can identify a possible fit, this material will be documented in a classified section of the report. It will provide incentive to get these available to you in the future or as a point of departure to make these available to you through your local secure facilities (if they exist). Examples of formerly classified images are shown in Figures B1 through B3 (originals are more detailed than can be reproduced here.)

Figure B1. Single-maneuver tracks are visible in the original of this satellite photograph taken over Fort Knox, October 1964.

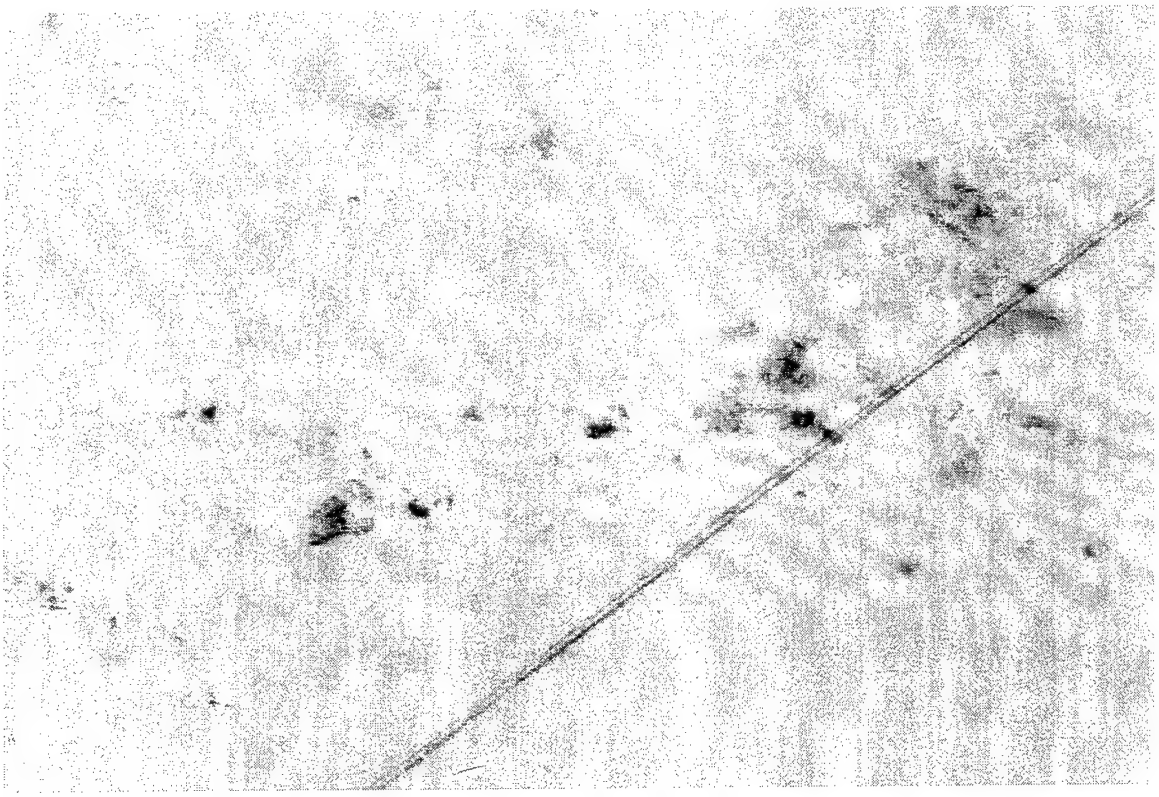

Figure B2. This satellite image of Fort Bliss, TX/NM shows two-lane Highway 51 on 24 November 1964.

Figure B3. This image of the western edge of Fort Irwin was taken 18 February 1964.

Appendix C: Interview Form

Discussion

Date: _____ .

Interviewed Individual: _____ .

Title/Office: _____ .

Address: _____ .

Phone/fax _____ .

Email address: _____ .

Date: _____ .

Has this person worked regularly with the local ITAM representative? _____ .

Any previous experience with this material? (If so document, get references. We are looking for documentation of success stories.) _____ .

What about this experience contributed to it becoming a success? _____ .

What were the biggest problems in dealing with this material? _____ .

How could the process be improved? _____ .

How were they able to get access to the data? Is that the best way? _____ .

Have they had any experience with using the NIMA products? _____ .

Have they had any experience with using the GATF or the DoD Fiducial Sites program? _____ .

After presenting the imagery character and potential applications, what are those items which the installation individuals feel would have potential application? _____ .

How important are these applications? _____ .

Do they have a high value in terms of:

Cost savings? How much (roughly in dollars)? _____ .

Does this save time? _____ .

Can you do things more quickly? _____ .

Do they currently have the facilities to take advantage of these? _____ .

In terms of handling classified materials _____ .

Have they ever worked with the Intelligence Unit folks at the installation? _____ .

– Do they know if they can get access to their existing local facilities? _____ .

– Local POC name/address/phone/email. _____ .

In terms of staff who would be able to identify the characteristics from the imagery, which are important to the application?. _____ .

"Ocular inspection" _____ .

Digital manipulation. _____ .

Image processing. _____ .

Integration with existing GIS data set.. _____ .

Do they know that many other governmental agencies with which they may work may also have faculties to handle the materials? Ex-Fish and Wildlife have SKICS for this purpose. _____.

How interested do these folks seem in trying this out? _____ .

Have they gotten any guidance from their MACOM or above on this question? If so, from whom? (names, phone, e-mail) _____ .

To begin to use this information would you folks need or desire:

Example Application Documentation materials _____ .

Workshops _____ .

Educational Forums _____ .

Funding to implement a local facility? _____ .

How much and for what? _____ .

Appendix D: Army Installation Points of Contact (POCs)

POC	Office Symbol	Street Address	City	State and Zipcode	Telephone Number	E-mail Address
Alvin Char	Environmental Division	Directorate of Public Works	Schofield Barracks	HI 96857-5013	(808) 656-2878, EXT 1062	chara@schofield-emh1.army.mil
Bob Coleman	Environmental Compliance Office	Building 2033, First Avenue	Fort Chaffee	AR 72923	(501) 484-2516	Cole-mang@doimex1.sill.army.mil
Brian Cochrane	DENR	Bldg 810, Yakima Training Center	Yakima	WA 98901	(509) 577-3402	coch-ranb@lewis.army.mil
Burla Martin	Directorate of Environmental C&M	801 Tevis Street	Fort Carson	CO 80913-4000	(719) 526-4907, EXT 0973	martinb@carson-exch1.army.mil
Chris Damour	ATZH-DIE	USASC Fort Gordon	Fort Gordon	GA 30905-5040	(706) 791-6482	da-mourc@emh.gordon.army.mil
Col. Newing, et al.	AEC	U.S. Army Environmental Center	Aberdeen Proving Grounds	MD 21010	(410) 671-3618	----
Dave Aslesen	AFRC-FM-TMR-I	110 East Headquarters Road	Fort McCoy	WI 54656	(608) 388-4783	asle-send@emh2.mccoy.army.mil
Gary Larson; Jeff Andrews	APVR-RPW-EV	730 Quartermaster Road #6500	Fort Richardson	AK 99505-6500	(907) 384-3074	jan-drews@cemml.colostate.edu
Glenn Wampler; Keith Harris	ATZR-BN	Directorate of Environmental Quality	Fort Sill	OK 73503-5100	(580) 442-4324	har-risk@doimex1.sill.army.mil
Jackie Schlatter	MCGA-PW-ENR	Building 4196, 2202 Fifteenth Street	Fort Houston	TX 78234-5007	(210) 221-5093	jackie_schlatter@smtplink.medcom.amedd.army.mil
Jeff Keating	AFZNESC	DES Conservation Division	Fort Riley	KS 66442-6016	(913) 239-6211	keatingj@riley-emh1.army.mil
Jerry Thompson	MCGA-PTM-TAM	Camp Bullis Training Site, Bldg. 5902	Fort Sam Houston	TX 78234-5066	(210) 221-5069	----
Jim Olsen	DLE-PSES-WO	Building 2441	Fort Jackson	SC 29207-5670	(803) 751-7271	ol-senj@jackson.army.mil
Jim Rapant	AFZS-EH-E		Fort Drum	NY 13602-5097	(315) 772-4852	rapantj@drum-emh4.army.mil
John Brent	U.S. Army Infantry Center	Environmental Management Division, Meloy Hall	Fort Benning	GA 31905-5122	(706) 545-2180	Brentj@benning.army.mil

POC	Office Symbol	Street Address	City	State and Zipcode	Telephone Number	E-mail Address
		(Bldg 6)				
John Martin; James Mikkelsen	STEDP-DEP-CP	Dugway Proving Grounds	Dugway	UT 84022	(435) 831-3580	jomartins@dugway-emh3.army.mil; jmikkel@(the same)
John Phillips	ANAP-OPI	18872 A.P. Hill Drive	Fort A.P. Hill	VA 22427-3106	(804) 633-8752	john_r_phillips@belvoir.army.mil
Lance Locklear	----	----	Fort Bragg	NC	(910) 396-8207	lock-lel1@bragg.army.mil
Marty Skoglund; Gary Swenson	----	15000 Highway 115	Little Falls	MN 56345-4173	(320) 632-7201	skoglunm@fmo.dma.state.mn.us
Sheridan Stone	ATZS-ISB	USAIC & FH	Fort Huachuca	AZ 85613-6000	(520) 533-7083/7084	stones@huachuca-emh1.army.mil
Steve McCall	ATZF-PWE	Building 1407	Fort Eustis	VA 23604-5332	(757) 878-4123, EXT 294	mccalls@eustis.army.mil
Tom Harshbarger	AFZB-PW-E	Building 865, 16th Street and Ohio	Fort Campbell	KY 42223-5130	(502) 798-9761	harshbarger@campbell-emh5.army.mil
Valerie Morril; Rubin Hernandaz	STEYP-CD-ES	Bldg: 2024; GIS Lab Center, U.S. Army Yuma Proving Grd	Yuma	AZ 85365-9107	520-328-2244	valerie.morrill@yuma-exch1.army.mil

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14. ABSTRACT

The United States is making both formerly and currently classified satellite imagery available for environmental evaluation purposes. The research reported here investigated whether Service-wide military land managers have uses for this material. The survey of military installation land management offices found that these managers were enthusiastic about the potential application of the material to their land management needs, but they generally wanted to see examples of what is available, particularly for their installation. The survey also concluded that they are in a relatively good position to begin the application of declassified imagery for land management at the installations because the staff is capable, interested, and has access to the technical resources to run sophisticated analyses. Some installations have successfully applied the imagery. The most commonly requested potential applications are also those that can be the easiest to carry out and provide the greatest cost savings. Access to secure resources on the installation and the need for clearances are not perceived as overwhelming obstacles. Funding is not perceived as a major issue, though this may change. To actually integrate the imagery use into their offices, however, there was near unanimous agreement that workbook examples and educational materials needed to be developed.

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